Plate I.

Internal surface of the Stomach of a child of nine years who was poisoned by Arsenic, ("Rough on Rats"). Contents of Stomach—four ounces of fluid containing Yellow Sulphide. (See page 382.)

A SYSTEM

OF

LEGAL MEDICINE

BY

ALLAN McLANE HAMILTON, M. D.

CONSULTING PHYSICIAN TO THE INSANE ASYLUMS OF NEW-YORK CITY, ETC., ETC.

AND

LAWRENCE GODKIN, ESQ.

OF THE NEW-YORK BAR

WITH THE COLLABORATION OF

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ILLUSTRATED

VOLUME I

NEW-YORK
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1894

PREFACE.

In presenting these volumes the Editor realizes the seriousness of the work that has engaged his attention for a number of months, and trusts that the production of an encyclopædic book of reference of convenient arrangement, containing special articles written by authorities in their respective branches, will commend itself to the many thinking physicians and lawyers into whose hands it may fall. It has been his aim to make it in every sense an original embodiment of the most advanced knowledge of the subject, free from the redundancies which are apt to fill the pages of many technical works of this character. To those who expect a collection of statistics and references it will doubtless prove a disappointment, but there is no difficulty in obtaining such material elsewhere.

An experience of almost a quarter of a century has convinced the Editor that both medical and legal practitioners, in the preparation of their cases, need just such information as they will here find in a concise and easily accessible form, and it is hoped that the lawyer and the doctor who go into court will, without much effort, obtain the needed aid.

The legal contributors who have so kindly helped the Editor have been requested to prepare special articles upon subjects which most frequently arise in court, and are usually neglected in treatises upon medical jurisprudence, or, at best, are but superficially noticed.

It is hoped that the reader will enjoy the Editor's satisfaction in the presentation of much experimental work and new

material which is inseparable from advanced forensic medicine. It would be unfair to single out examples of such research, but the painstaking and thorough experiments in regard to the effect of gunshot wounds, the inquiries relative to the importance of blood-stains, and the novel and significant investigations in regard to ptomaïne poisoning in the first volume, may be cited as examples of the general industry and progressive methods of the contributors generally; and the new material relative to railway neuroses, aphasia, and medical and surgical malpractice, in the second volume, is an earnest of what the writers upon these subjects and the others have done.

The thanks of the Editor are due to *Dr. Hebbert*, lately associated with Mr. Bond, the Coroner of London, England, who has, in conjunction with Dr. F. A. Harris, presented for the first time in a book of medical jurisprudence the records of the Whitechapel murder cases, and the deductions therefrom, which must in future play a great part in the determination of the identity of the dead body.

It has been the aim of the Editor and his associates to be as impartial as possible in their treatment of the different subjects, and it is expected that this work will further the rights of the people and the prisoner as well, and be in every way a safe and useful guide.

ALLAN McLANE HAMILTON.

NEW YORK, May, 1894.

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CONTENTS OF VOLUME I.

LIST OF ILLUSTRATIONS.

VOLUME I.

PLATES.

WOOD-CUTS AND HALF-TONE ENGRAVINGS.

INTRODUCTION.

MEDICAL jurisprudence, or legal medicine, may be defined as the science which applies the principles and practice of the different branches of medicine to the elucidation, in judicial proceedings, and subject to legal rules and forms, of questions relating to the cause or time of death, conception and birth, or the cause or effect upon the legal status of individuals of mental or physical disease or injuries.

The questions which are included in this definition have been divided into five classes, the first of which includes inquiries arising out of the relations of sex, as impotence and sterility, pregnancy, legitimacy, and rape; the second, injuries inflicted on the living organism, as infanticide, wounds, poison, injuries, and death from violence; the third, questions arising out of disqualifying diseases, as the different forms of mental alienation; the fourth, those arising out of deceptive practices, as feigned diseases; fifth, questions of a miscellaneous nature, as age, identity, presumption of seniority, and life assurance.

Of course the means or instrumentalities by which the principles and practice of medicine are applied to the elucidation of questions of law are the utterances of persons skilled in medicine, to wit, of physicians, surgeons, and chemists. These utterances, whether oral or written, are made use of in courts of justice, subject to certain rules which have been adopted as best calculated to correct or assist the infirmities of the human character, mind, and memory.

In a general way the evidence given by medical and chemical experts has been classed as "opinion" evidence—that is to say, as evidence which consists in the expert giving the conclusions which he, as a scientific man, draws from certain facts which have been, or are supposed to have been, proved. But owing to the progress of the science of medicine, and as the result of the modern scientific methods of investigation with accurate results, medicine and chemistry have become more worthy to be classed as exact sciences, and much of the testimony of physicians which formerly might rightly have been classed as pure matter of opinion is now as much a statement of matter of fact as a statement of the law of gravity, or the fact that the earth moves around the sun. And while it is to a large extent still true—as was laid down in a case in New York which established the proposition that the law does not recognize any particular class or school of practitioners as qualified experts to the exclusion of other classes or schools—that medicine is not an exact science in which truths have become established and fixed, but that, on the contrary, it has been characterized in a greater degree by fluctuation of opinion as to its principles and the mode of practice than perhaps a

other pursuit, and has been distinguished by the constant promulgation and explosion of theories, and that the popular axiom that doctors differ is as true now as it ever was, still on the other hand, there has been, ever since the discovery of the circulation of the blood, a steady progression in medicine toward the establishment of an increasing collection of fundamental and precise scientific facts, which are almost as reliable, as premises, as any of the facts in nature of which courts have for many years taken judicial notice without proof. This is especially true of that division of medicine which is known as pathology as distinguished from therapeutics, and in which the modern scientific school of medicine has made such wonderful discoveries, by means of methods of demonstration and proof which have raised the results out of the domain of controversy.

Nor is the complaint which Bacon made in the seventeenth century—that the science of medicine had departed from the true path trod by Hippocrates, who used to set down a narrative of the special cases of his patients, and how they proceeded, and how they were judged by recovery or death—any longer applicable: for to-day a large part of the science of medicine consists, like the profession of the law, in studying and reporting new cases and decisions for the direction of future judgments. It is his learning and experience, drawn from the "myriad of single instances," which qualify the medical expert and gives his opinion, in the specific instance in issue, gravity and weight. In the actual practice of medicine it is still true, as of old, that the physician is judged to a great degree by the recovery or not of his patient, either of which results may be due to a hundred causes other than the skill or ability or incompetence of the physician; but in forensic medicine the expert is judged by the knowledge and learning evinced in his testimony, and not by the result of the trial. And in these days of criticism and belittling of expert testimony on the grounds that it consists of bought opinion, it is well to bear in mind the remark of that prince of practical philosophers, Dr. Johnson, who, when Sir James Johnston said that he paid no attention to arguments of counsel at the bar of the House of Commons because they were paid for speaking, replied: "Nay, sir, argument is argument. You cannot help paying regard to their arguments if they are good." And so in the case of expert testimony, if the opinion or argument of the expert appears sound and weighty, and to be based on sound premises, it is no answer to the impression it may make upon the minds of the hearers that the expert was paid for testifying.

Although the principles of medical science were applied to the determination of certain legal questions by the Greeks and Romans, there is nowhere any authoritative mention of such a procedure in actual trials. There is some doubt whether in Roman criminal trials the accused was himself allowed to call any witnesses in his own behalf except as to his general character. Mr. Trollope, in his *Life of Cicero*, says that he was not. There does not seem to be any allusion either in the Digest or the Theodosian Code to insanity, or any form of mental alienation, as a defense to prosecution for crime; but we know that the subject was fully recognized under the system of Roman jurisprudence, and that insane persons were regarded as having no intelligent will, and as therefore being incapable of having rights or responsibilities, and that their persons and property were placed, after due investigation by magistrates,

under the custody of curators. It is very probable that in such proceedings expert testimony was relied upon to some extent at least. In Rome, under both the republic and empire, and elsewhere in Europe during the middle ages, human suffering produced by physical torture was relied upon in criminal procedure to extort confessions or other evidence which might be used against the prisoner, and during all these dark ages of the criminal law we hear but little of medicine as an adjunct to, or a mitigator of, its enforcement. Torture played a prominent part in Roman criminal procedure, particularly in the preliminary investigation after the arrest of the accused. Slaves were tortured when their masters were suspected of offenses, and the accused himself might be tortured repeatedly when the evidence against him was particularly strong. It is worthy of note here that the Roman law was especially severe upon the crime of poisoning, and extended its provisions to every one, "*qui venemum necandi hominis causa fecerit, vel vendiderit*," and that the crime of rape was specially provided for, and was not included under the "*Lex Julia de Adulteriis*," which apparently was intended to cover every other sort and description of sexual crime. But the crime of murder or attempted murder by poison has always been regarded with special abhorrence in ancient systems of law. By the Statute 22 Hen. VIII. it was provided that willful poisoners should be boiled to death; and in the trial of Richard Watson for poisoning in 1615 Lord Coke declared that "of all felonies murder is the most horrible; of all murders, poisoning the most detestable; and of all poisoning, the lingering poisoning." (*State Trials*, vol. ii., p. 91.)

The idea of preliminary torture of the accused with a view to extracting from him a confession, or evidence that can be used against him, is preserved, although of course in a very much modified and milder form, in the French system of criminal procedure. In France the *juge d'instruction*, who in some respects corresponds to our committing magistrate, may put the prisoner in solitary confinement for an indefinite time, and during the time question him in secret as often as he desires. This secret interrogation may be carried on without giving the accused any information as to the nature of the evidence against him, and every art of verbal torture—in addition to the solitary confinement—calculated to extort from him a confession may be used against the unfortunate prisoner.

The system of trial by ordeal which existed, particularly in England, in the middle ages, and even up to the sixteenth century, may have sufficient interest to the student of legal medicine to deserve a passing mention. In England, under this system, if an accused person could not get a sufficient number of satisfactory "compurgators," or persons who would swear to their belief in his innocence, he was put to the ordeal. This ordeal might be of various descriptions. It sometimes consisted in compelling the accused to handle red-hot irons, or plunge parts of his body into boiling water, and if the skin showed any mark of burn or scalding, he was guilty. Another form of the ordeal was to throw the accused into water, and if he sank he was innocent, and if he floated he was guilty. These ordeals, whatever might be their nature, were simply tests of human endurance of such a kind that only a reversal of some law of nature could enable the victim to successfully support them.

The real beginning of the science of forensic medicine is generally ascribed to the publication in 1553, by the Emperor Charles V. of Ger-

many, of the *Constituo Criminalis Carolina*, or Caroline Code, in which it was directed that the opinion of medical men should be taken in cases where death was alleged to have occurred by violence, and suspicion existed of a criminal agency. But it was not until the seventeenth century that we began to have authentic recorded instances of the employment of forensic medicine in England, and in some of the English state trials of that time we find cases in which medical men were called upon to testify in criminal trials; but in a large class of inquiries which are to-day the subject of medical examination and testimony, medical men were not consulted. For instance, we know that in applications for postponement of the sentence of death on account of pregnancy, in prosecutions for rape, and in applications for a decree of nullity on the ground of incapacity to consummate the marriage contract, it was the practice to impanel a jury of matrons to examine and report to the court. In the trial for murder of Jane Norkott, in 1628, there is a curious instance of the disinterment of a body for a second inquest thirty days after the first inquest had been held. At the first inquest the coroner's jury rendered a verdict of suicide. It was shown upon the trial that when the body of Jane Norkott was disinterred for the second inquest, one of the persons accused of her murder touched the dead body, "whereupon the brow of the dead, which before was of a livid and carrion color, began to have a dew or gentle sweat arise on it, which increased by degrees till the sweat ran down in drops on the face, the brow turned to a lively and fresh color, and the deceased opened one of her eyes and shut it again; and this opening the eye was done three several times; she likewise thrust out the ring or marriage finger three times and pulled it in again, and the finger dropped blood on the grave." (14 State Trials, 1342.)

In 1665 occurred the trial of the Suffolk witches, Rose Cullender and Amy Duny, on a charge of bewitching children, in which we find one of the most enlightened and distinguished physicians of the time, Sir Thomas Browne, author of the *Religio Medici*, testifying to his belief in witchcraft, and it was largely upon his testimony that the unfortunate women were convicted and hung. As an illustration of the value of the best medical testimony in England in that day, it is worth while to quote Dr. Browne's testimony in court, delivered after an examination of the two accused women and the aunt of the children alleged to have been bewitched. It seemed that Rose Cullender and Amy Duny had quarreled with the parents of the children; that the children subsequently had fits and threw up crooked pins and a twopenny nail with a broad head, and that thereupon a bee brought the nail and forced it into the child's mouth; and the two children declared that the prisoners were tormenting them, and that they saw their apparitions. There was other evidence, but the foregoing was the most weighty. After hearing the evidence and making his examination, Dr. Browne, having been called on for his opinion, stated to the court that "he was clearly of opinion that the persons were bewitched, and said that in Denmark there had been lately a great discovery of witches, who used the very same way of afflicting persons by conveying pins into them, and crooked as these pins were, with needles and nails. And his opinion was that the devil in such cases did work upon the bodies of men and women upon a natural foundation (that is) to stir up and excite such humours superabounding in

their bodies to a great extent, whereby he did in an extraordinary manner afflict them with such distempers as their bodies were most subject to, as particularly appeared in these children; for he conceived that these swooning fits were natural, and nothing else but that they call the mother, but only heightened to a great excess by the subtlety of the devil coöperating with the malice of those we term witches, at whose instance he doth these villainies."

In his *Religio Medici* (part i., sec. 30) Dr. Browne emphatically affirms his belief in witches, and describes those who do not believe in them as "a sort not of Infidels, but Atheists." In charging the jury in the case just alluded to, Chief-Justice Hale said "that there were such creatures as witches he had no doubt at all."

In the early part of the eighteenth century we have what is probably the first recorded instance of a criminal trial in which the result depended largely upon the conflicting evidence of medical experts. The case was that of Spencer Cowper, an Englishman of high position, who was accused of the murder of a Quakeress, Sarah Stout by name. Miss Stout's body was found one morning in a mill stream. There was evidence to show that the last person who had been with her on the night before was Cowper. He was tried for her murder, and a considerable number of physicians were called by the prosecution and defense to establish or controvert, among others, this proposition: that "it is contrary to nature that any persons that drown themselves should float upon the water; we have sufficient evidence that it is a thing that never was; if persons come alive into the water, then they sink; if dead, then they swim." Witnesses were also called to prove the proposition that water must be found in the stomach of a person who died of drowning, and that its absence was inconsistent with death so caused. The case was prosecuted and defended with great energy and vigor, and resulted in Cowper's acquittal. Baron Hatsell, who presided at the trial, made some remarks upon medical testimony in the course of his charge to the jury, which have a decided resemblance to some of the reflections which are made to-day by judges charging the jury upon the merits of the same kind of evidence. Baron Hatsell said: "You have heard also what the doctors and surgeons said on the one side and the other concerning the swimming and sinking of dead bodies in the water; but I can find no certainty in it, and I leave it to your consideration. The doctors and surgeons have talked a great deal to this purpose, and of the water going into the lungs or the thorax; but unless you have more skill in anatomy than I, you will not be much edified by it." (13 State Trials, 1188.)

In another criminal trial somewhat later we find a very curious result of the denial to the prisoner of the assistance of counsel in trials for felony. At the trial of Lord Ferrars, the prisoner set up the defense of insanity, and was obliged himself to examine the witnesses whom he called to support this plea.

In the nineteenth century the development of the science of forensic medicine has been rapid and important, and a quantity of literature has appeared upon the subject. Some of the best known names of contributors to the science are those of Orfila and Tardieu in France, Casper in Germany, Christison, Taylor, Guy, and Ogston in England, and Beck, Reese, Wharton and Stille, and Wormley in the United States. The increasing complexity of modern life resulting as it has in a marked in-

crease in the quantity and variety of litigation, the rapid strides in the direction of accurate knowledge and means of scientific investigation which have been made in medicine, surgery, and chemistry, and the tendency to a relaxation of the strictness of the old common-law rules of evidence, have all contributed to activity in the domain of forensic medicine and to the enlargement of the field of its application.

Recurring to the definition of medical jurisprudence which has been given, it is obvious in the first place that a wide field of science may be covered by the terms "principles and practice of medicine." Anatomy, physiology, medicine, surgery, chemistry, and physics, all come to a greater or less extent within the province of the science of medicine, and they are all constantly called upon to contribute to the elucidation of legal questions affecting life, liberty, and property. It may be said that the progress which has been made in the application of the sciences of toxicology and pathology in courts of law has greatly increased the difficulty of successfully concealing the crime of death by poisoning.

Nor is the category of the kind of judicial proceedings in which the assistance of the trained medical witness is invoked less varied than the nature of the subjects covered by the science of medical jurisprudence. The determination of the capacity of testators to make wills, of contracting parties to contract, and in the marriage relation to consummate the contract, the decision of property rights depending upon questions of legitimacy, survivorship, age, and identity, mental capacity to take and hold property, are all familiar instances on the civil side of the law of the daily application of the science of medical jurisprudence to assist courts and juries in arriving at just conclusions in regard to property rights; while in the criminal branch of the law, the increasing frequency with which mental alienation is interposed as a defense to prosecution for crimes of violence, the necessity of the ascertainment of the causes, and probable means or instrument, of death or injury, and the duration and effect of such injuries, and questions arising out of what is known as hypnotism, which has already more than once been interposed in France as a defense to criminal prosecutions—all furnish a class of cases in which the testimony of the medical expert is indispensable. It is to be noted, however, that the statute law of many of the States has interposed a wise and salutary check upon possible forms of abuse of the confidential relation which must of necessity exist between physician and patient, by prohibiting the disclosure by a physician of communications made by, or information received from, the patient while in attendance upon him in a professional capacity. This topic will be fully treated in a subsequent article. It is an instance of a class of cases in which expert testimony is limited or excluded on the same well-founded grounds of public policy which has caused the enactment of laws prohibiting the disclosure of confidential communications made by clients to their attorneys, and persons to their spiritual advisers.

Under the systems of legal procedure which obtain in England and the United States, the contesting parties to the proceeding select their own experts and pay them. That this system has in some cases led to abuse, and that it has, particularly in the last few years, had a tendency to throw discredit upon all medical expert testimony, cannot be doubted. The spectacle which is now constantly witnessed in our courts, of equally qualified experts called on different sides of a case flatly contradict-

ing each other, must of necessity cast doubt either upon the reliability of medical opinion, or else upon the standing of medicine as an exact science. But as the real object of all judicial proceedings is the ascertainment of truth and the doing of justice, the important question is whether our system conduces to these ends to a greater or less extent than the system in vogue elsewhere. As regards this question there is much room for discussion and difference of opinion. But that there is a growing restiveness on the part of judges, juries, and experts themselves under the faults and defects of our system, and a casting about for some better solution of the problem, is undoubted. A very brief statement of how it is managed in France and Germany, where the English and American system of common law procedure does not exist, may be not without interest.

In France the court may order an investigation and report (*expertise*) by experts whenever it deems it advisable. If the parties cannot agree upon the experts the court appoints them. They are at least three in number, and are generally, though not necessarily, selected from a list of specialists termed *experts assermentés.* The order directing the investigation contains a statement of its precise object, and appoints a referee, or *juge commissaire.* Barristers, or *avocats,* are not allowed to appear before the experts, but the parties are represented before them by solicitors (*avoués*), and sometimes by persons specially skilled in the matter of the investigation. The report must be signed by all three of the experts; and if there be a dissent, the dissenting opinion and the reasons for it are set forth in the body of the report. The judges, however, are not at all bound by the report if it is opposed to their convictions. ("*Si leur conviction s'y oppose.*" *Code de Procédure Civile,* titre quatorzième.)

In Germany since 1870, under the Code of Civil Procedure for the German Empire, after the issues are framed upon which expert testimony is sought, the parties may agree upon the experts, and the court appoints those agreed upon, but it may confine the parties to a given number of experts. Sometimes the court submits to the parties the names of a number of experts, and allows each side to object to a certain number of them, and then appoints those remaining. There exists in Germany a class of officially appointed experts on certain subjects, and in trials which concern these subjects such experts have the preference in appointment, unless there exists some special reason why they should not be appointed. In Prussia, for instance, it is said to have been the custom to appoint as experts a physician and surgeon for every county. In addition there was a medical college in each province to which an appeal lay if the experts disagreed or the parties desired it. In addition to this there was an appellate medical commission for the whole kingdom. (Rogers, *Expert Testimony,* § 41.) But in Germany, as in France, the court is not constrained to follow the expert opinions, and if it is not satisfied with them it may order a new expert opinion from the same or from other experts.

The plans for reform in the American system of calling expert witnesses have generally been in the direction of establishing a class of official experts; and the trouble with most of the plans is that they contravene one or all of the three fundamental ideas of our system of criminal trial, to wit, that the judge alone is to be the judge of the law, that the jury alone are to pass on the facts, and that the accused shall be

allowed to produce any relevant and competent evidence in his own behalf. The plan suggested by Sir James Fitzjames Stephen at the end of the first volume of his *History of the Criminal Law of England*, would seem to meet the situation, although it is one which requires a very high standard of medical honor and knowledge. It seems that under this plan, which has been for some time in operation at Leeds in England, medical men refuse to testify unless before doing so they can meet in conference with the expert witnesses to be called on the other side of the case, and have an interchange of views. And it is stated that the result is that at Leeds medical witnesses are hardly ever cross-examined at all, and it is by no means uncommon to have them called on one side only. If such a system could be adopted by the profession in America it would be of immense service in raising the standard of expert testimony, and increasing the reliance placed upon it by the courts and juries.

The adoption by the medical profession of some such plan as this, is, in the opinion of the writer of this brief and inadequate introduction to the great science which is treated in the following pages, the proper solution of the difficulty. And not its least merit lies in the fact that it may thus be brought about by the members of the profession taking the matter into their own hands, and dealing with it upon the lofty and disinterested plane upon which the medical profession should be moving on to the great future which, as an instrumentality for the attainment of righteousness and justice, as well as the retarder of death and the alleviator of human suffering, is surely before it.

LAWRENCE GODKIN.

MEDICO-LEGAL INSPECTIONS AND POST-MORTEM EXAMINATIONS.

BY

A. T. BRISTOW, A.B., M.D.

A POST-MORTEM examination as ordinarily undertaken is made for the purpose of determining the cause of death where this is the result of disease, to observe the resulting pathological changes, their nature, and extent, together with the organs implicated.

The inquiry concerns the physician himself. The friends of the deceased are disposed to accept the results of the examination without question, and with the signing of the death certificate the function and responsibility of the examiner cease. In the case of a medico-legal inspection the responsibility of the examiner is much increased. On his report and testimony may depend the issue of a civil damage suit, or, more important still, the arrest of a freeman, his prolonged imprisonment, indictment, and trial. The liberty of the citizen and the vindication of the law alike demand that the examiner should proceed with the utmost circumspection, to the end that the guilty may not escape nor the innocent suffer. It is to be remembered that when prosecution follows as a result of the inspection the examiner must expect that his methods will be subjected to the minutest scrutiny, and bear the test of hostile criticism from the acutest minds the defense can summon. Loose and inaccurate methods, hasty observations, deductions rashly drawn, may bring confusion on the medical witness and involve in ruin a righteous prosecution. On the other hand, it is to be observed that although the prosecuting officer may demand a victim, justice calls for the criminal. Not seldom it may be the duty of the medical witness to stand between the unfortunate and an ambitious or too zealous prosecutor, carried away by the ardor of battle, the hope of future gain or preferment. In such a case too often the prosecution is degraded into an intellectual contest between the counsel for the defendant and the prosecuting officer, becoming a sort of prize-fight, in which the stake fought for is a conviction, a victory for the prosecution which may lead to professional distinction, possibly political preferment. When such motives prevail, it is not strange if the medical witness, especially when retained by the prosecution, enters upon his investigations with a biased mind. Such an attitude is not conducive to that judicial spirit which the task of a medical examiner requires. It may be objected that it is the function of the examiner simply to determine certain facts and report accordingly, it being for the

jury to judge of their significance. It may be observed, in reply, that there are many instances where the jury must be guided solely by the inferences of expert witnesses, amended and clarified by proper cross-examination and comparison. It is this very lack of the judicial spirit which has brought the opinions of the expert witness into well-deserved discredit. He is too apt to regard the case from the point of view of the side that employs him, and so looks rather for what he hopes or wishes to find than at the facts as they really are.

That medical witnesses should be entirely free from bias is expecting too much, perhaps, under the present system; but it is certainly their duty, as honest and true men, as far as in them lies to divest themselves of every feeling which is likely to give their minds a slant. The medical witness should therefore be on his guard, and with his natural desire to serve those who have employed him yet keep his judgment unclouded. It is quite possible to be mistaken with regard to even natural appearances. The writer has seen the petechiæ of the early stage of decomposition mistaken for the marks left by contusions. It is unnecessary to point out the possible consequences of such an error. Because of similar blunders, payments on policies of life insurance have been refused, and criminal prosecutions instituted involving the innocent in ruinous expense, perhaps even jeopardizing human life.

Post-mortem examinations made for forensic purposes may be classified as follows:

1. Before burial: (*a*) examination made soon after death, before decomposition has set in; (*b*) when decomposition is far advanced.

2. After burial: (*a*) before the soft parts have lost their identity; (*b*) at a more remote period, when the bones only are left, the soft parts having either disappeared altogether or been merged in an undistinguishable mass.

In all medico-legal examinations the examiner should be accompanied by at least one other physician not only as an assistant, but also as a witness. It shall be his duty to write out an accurate and full account of the proceedings of the examiner at his dictation, with the findings, together with a description of the methods employed. The journal should be kept in ink, and signed and sworn to by both the examiner and his assistant, also by any other physician who may be present. It is important that every organ should be examined, not excluding the spinal cord and the ribs, especially the first and second. A full and complete examination should be the rule in every case, to which there should be no exception. Ogston relates a case in which, owing to the fact that the examination of the spinal cord was omitted, the prosecution failed to convict. The case was as follows: Two men having quarreled, one of them in the struggle which followed strangled his opponent by twisting his neckcloth violently. In the subsequent trial the defense claimed that the deceased lost his life from spinal hemorrhage, and the cord not having been examined, the prosecution was unable to disprove the claim of the defense, and lost. It is important to examine the ribs, not neglecting the first and second. In an autopsy held by Dr. Van Cott at the Brooklyn City Hospital on the body of a man who died from injuries received from falling into the hold of a ship, the writer saw a quantity of blood in the left pleural cavity, which had come from a wound in the left subclavian vein, made evidently by a sharp spicule of bone from a

fractured first rib. So too the laminæ and bodies of the vertebræ should be examined. The inspection cannot be too minute or precise.

It is always a very great advantage for the medical examiner to be able to make the inspection and autopsy at the place of death, and, if possible, before the body has been interfered with or moved from the spot where it lay when discovered. There are many facts connected with the position of the corpse, its distance from a bed, door, or stairway, which might be of the utmost importance as bearing on the cause of death, yet which would almost certainly escape the lay witness. Such details as these would be estimated at their true value by the medical examiner, and noted accordingly.

It will be seen that the rôle of examiner is thus extended beyond the mere making of an autopsy. It is certainly high time that the important data which may be obtained from a proper examination of the premises should no longer be left to the bungling of ignorant persons. At present, the court has to depend on the testimony of policemen and excited neighbors for what is in many cases vital evidence, and then falls back on the much-abused hypothetical question, which the medical examiner is required to answer categorically. It is certain that some change should be brought about in the nature of the judicial proceedings at present in vogue on the discovery of a homicide or supposed suicide, and known as a "coroner's inquest." The reform ought to commence at the very beginning, starting from the moment when the corpse is discovered. On the arrival of the officer, he should first satisfy himself that life is extinct. A physician will usually have been summoned, so that he will not have to depend on his own judgment to determine this important point. This done, he should close the room and permit no one to enter. In cases of suspension, the body should always be cut down at once; nor is this so unnecessary a direction as may at first sight appear. Instances have not been wanting where an absurd fear of interfering with the coroner has prevented this, although life was not entirely extinct. A life may thus have been sacrificed which might have been saved. Under all other circumstances it is better that the body be not in any respect disturbed, nor should any article of furniture, wearing-apparel, household utensils, or weapons be moved from the position where first discovered. If evidences of a struggle are apparent in other apartments, not only should the room be closed where the body was discovered, but also the whole house, and left in charge of an officer, the inmates being either confined to their rooms or allowed to remove to other quarters. At all events, they should not be permitted to roam about the premises unhindered, at full liberty to commit any indiscretion, or, if necessary, make preparations to conceal evidences of crime. The coroner's office having been notified, a duly authorized medical examiner should at once go to the house, and with his assistant, and possibly a representative of the law-officer, make the necessary medico-legal inspection of the body and its environment. After the autopsy, and on the written permission of the examiner, the body may be properly cared for, but under no circumstances should the use of any embalming fluid be permitted. Such further arrangements may then be made as cleanliness and necessity may require. The inmates may be allowed such liberty in the house as may seem advisable to the law-officer. They shall, if they desire, be allowed the privilege of accompanying the medical inspector in his search, either

in person or by representative, but shall not be allowed to remove articles of wearing-apparel or other articles until written permission has been obtained from the medical inspector. Such a proceeding as this may seem unnecessarily harsh, yet it will not only prevent guilty inmates from removing evidences of their crime, but will also protect the innocent by deterring them from the commission of actions which might render them liable to suspicion. Had such regulations been carried out in the Borden house after the discovery of the bodies, is it likely that Lizzie Borden would have been put on trial for her life? She certainly would not have been permitted to destroy clothing as she did, innocently enough, perhaps. Yet this error of judgment was one of the strongest inducements to the State to hold her for trial. It certainly was one of the strongest points against her.

Such ill-considered acts are to be expected from persons laboring under great excitement, as must be the case where relatives or even strangers have been found struck down by the hand of violence. Prudence is not to be expected under such circumstances, and the innocent may not only do things unwittingly which may destroy evidence, but also be the means of entangling them in the meshes of the law.

It may be said of such a procedure that it would be impracticable in rural districts and in lonely situations; but there is no hamlet without its village constable and justice of the peace. The latter, in the absence of the regularly appointed examiner, might delegate the office to the village practitioner, whose observations would be far more likely to be of service to the court than those of the constable or the casual neighbor. Other processes of law are carried out in remote districts, and there is no reason why so important a function as a medico-legal inspection should not be likewise conducted in an orderly and precise manner. In most States the law makes no provision for such a procedure. In one State, however (Massachusetts), the medical examiner is a regular official appointed by the State, and this is a step in the right direction. It is to be hoped, however, that a more enlightened practice may ultimately prevail, and that the prosecuting officer will not have to depend on the testimony of ignorant persons and laymen for the preparation of what is often the most important part of the case.

It is rare at present for the medical examiner to have an opportunity to inspect the body and its surroundings before both have undergone interference and change. If, however, he has been so fortunate as to have forestalled this, on his arrival at the place of death he should first note accurately the position of the body, whether on face, side, or back. The position of the limbs should also be observed, especially that of the arms and hands. If there is a weapon in either hand, the position of the fingers with regard to the handle of the weapon should be carefully noted, as, for instance, whether tightly clinched upon or only loosely surrounding it. The nails of the corpse should be carefully inspected for shreds of skin, which in a struggle may have been scratched from the assailant. If found, they should be carefully preserved for future examination. So, too, the hands, when clinched, should be opened and examined for tufts of hair or fragments of clothing. These inspections should be completed before the removal of the body from its original position. A rough diagram of the room, which any intelligent man could make, will be of material assistance. On this may be plotted the

position of the body, together with that of every article of furniture in the room, and any weapon or weapons which may be discovered. Nor is it necessary to be a surveyor to do this with sufficient accuracy for the purpose. A tape-measure used with ordinary intelligence will give the required measurements, and these can be recorded on a rude diagram. Such a sketch shows at a glance the position of the body with regard to every article of furniture in the room, together with the distances. If a weapon is found in the room, its distance from the corpse can be indicated in like manner. If any blood-stains are found on the floor, whether in the room or without, their distance from the corpse should be noted, and if on the wall, their height. It is also of importance to notice the character of the stains, as, for instance, whether produced by the spouting of an artery or smeared on the wall or floor by hands or feet. With regard to the furniture in the room, the position of each piece should be noted, and whether disposed in an orderly manner or overturned. The bed should be examined with reference to the condition of the bedclothes, whether stained, in disorder, or undisturbed. The minutest detail is worth mentioning, for until the entire case is made up it is impossible to be sure that any fact is trivial and of no importance. It is, besides, extremely difficult to supply a link which may be essential to the evidence after all traces of the act of violence have been effaced from the spot.

With reference to the importance of noting the position of the body, as regards the different articles of furniture in the room, the following case may be cited from Christison. The deceased died from poisoning by hydrocyanic acid. The question arose whether it was self-administered or not. The body was found in bed, covered in an orderly manner with the bedclothes, while the vial which had contained the acid, together with a tumbler from which it had been drained, was in a distant part of the room. The whole case turned on the following point, as to whether a person, taking the poison with suicidal intent, could afterward set the tumbler and vial deliberately where found, then go over to the bed and draw the bedclothes up, before being overtaken by death. Here it was evidently of the utmost importance that the distance between the body and the vial and tumbler should be accurately known. So, too, in rapidly fatal wounds accompanied by violent hemorrhage, a knife or other cutting instrument may be found at a distance from the corpse, possibly in another room or part of the house. Irrespective of the nature and direction of the wounds, it may be asked whether it was possible for the deceased to traverse the distance between the spot where the weapon was discovered and that where the body lay, before death ensued. If the medical witnesses answer no, it is evident that the death was not self-inflicted. When the body has been discovered in the open air, similar, though less precise, observations are still possible. Accidents of weather may, of course, obscure or entirely obliterate much that would prove useful in the way of evidence; still, the vicinity should be carefully examined, especially for traces of a struggle. If found, the distance should be measured from the spot where the body lay to the farthest point where traces of a struggle are visible. If the body be that of a woman, the condition of the underclothes should be examined, and particular search made for seminal stains. Rape followed by murder is more apt to be perpetrated in secluded localities than near or in a dwelling, and therefore the evidence of such a crime should be looked for with

care. Often after an unsuccessful attempt at rape murder may be committed, either as a result of the violence used or with the object of concealment.

The foregoing remarks apply to the preliminary examination of the premises in which the body was discovered. Reasons have been given why it is best for the medical examiner to make this a part of his duty. Afterward he will proceed to the actual inspection of the body itself. The external inspection should always include an examination of the clothes. Bullet-holes in clothing should be inspected to determine the condition of the edges of the rents, for if these are burned, it is evident that the shot was fired at very close range. The cuts made by a knife or other sharp instrument should be counted and described. They may be afterward compared with the body wounds. Where the cuts in the clothes exceed those in the body, this fact is in itself a presumption against suicide, as self-inflicted wounds are not likely to miss their mark. The special examination of the clothing for seminal stains will be referred to and described in the article on Blood and Other Stains.

The actual examination of the body consists of two stages, the external examination and the internal. Let it not be supposed that the autopsy proper, the dissection of the body, and the inspection of the viscera form the most important or only important part of a medico-legal examination. It is often of the greatest importance to determine the identity of the corpse, and this is frequently a most difficult task. Nothing would seem to be easier than for a wife, brother, or sister to recognize the body of a deceased husband or near relative; yet there is hardly a body found, where the necessity arises for identification, which is not claimed by several different people. Nor are these false recognitions caused altogether by putrefactive changes, for the most extraordinary mistakes of recognition have been made before putrefaction has had time to occur. No doubt such errors are due in part to the changed appearance of the body after death; but there is also, in the natural desire of friends to recover the body of a near relative missing and supposed to be dead, an incentive to exaggerate the importance of slight points of resemblance, and to overlook points of marked dissimilarity. In no other way can we account for the mistakes of this sort which are being constantly made. The recognition of the corpse must depend, however, mainly on the external examination, together with such corroborative evidence as may be afforded by the clothing and other property found on the body. In this connection, it may be both useful and interesting to give several recent instances of mistaken identity which have come to the writer's notice. On September 3, 1893, there appeared the following account in the New York *Herald* of the case of Marcus A. Quinn: "He was entered as dead in the books of the morgue, and at the Bureau of Vital Statistics. A body was buried as his in consecrated ground in Calvary Cemetery, and yet on Tuesday (August 29th) he was found alive in the hospital of the almshouse. Quinn was employed as messenger and teacher in the office of the warden of the almshouse on Blackwell's Island. His wife, however, lived in the city, and Quinn was in the habit of visiting her every five or six days. He came to the city on leave of absence August 5th. Having been long away from his friends, he received a warm welcome, and it is said drank too freely, and afterward wandered about aimlessly. His wife, hearing of his vagaries through a

relative, became alarmed as time passed and he did not call upon her. She finally sent to Blackwell's Island, and learned that he was not there, but had been away for a number of days, and there was no clew to his whereabouts. She then went to police-headquarters on August 18th, and saw the following report, filed August 11th: 'The body of a man was found off Pier 9, East River; about fifty years old, five feet nine inches tall, weighing about one hundred and fifty pounds; gray hair and mustache, and beard about a week's growth; gray eyes; mixed black-and-brown ribbed vest, blue-and-brown striped trousers, white shirt, leather belt about the waist, black Prince Albert coat; in the water about five hours.' To Mrs. Quinn this description seemed to tally with that of her missing husband in every particular. She arrived at the morgue the following morning armed with a tintype. The body had been buried in Hart's Island, but the photograph taken before burial left no room for doubt in the mind of the wife. The pictures were compared and carefully scrutinized by the authorities at the morgue, and the policeman stationed there said, 'You could not tell one from the other.' Mrs. Quinn wanted to make sure. She went to Hart's Island on Monday, where the body was disinterred for her, and not only she, but her eldest son Matthew and a friend, positively identified the body as that of her husband. In a sealed coffin the body was taken back to the morgue, while the supposed widow went to the office of the Prudential Insurance Company, from whence an agent was sent to adjust the claim. To him the evidence seemed so complete that Quinn was dead that the claim, $165, was paid in full. The funeral followed, which the widow and her three sons attended, together with a friend. Even the clothing on the dead man was burned, so positive was the identification. Shortly after the funeral her eldest son, who was employed on the island steamer, walked in and told her that he had seen her husband in the hospital, and that she had buried the wrong man. It appeared that in his adventures about the city the man had contracted pneumonia, and had finally brought up in the hospital on August 29th."

With regard to the insurance money, it may be added that the woman paid it back at once, receiving a receipt in full from the company. Indeed, the small amount of the money, and the fact that the bulk of it must have been spent on the funeral, preclude the idea of a fraudulent identification. Here was a case where a body was positively identified by five persons, including the wife, as that of her husband. Not only were the city officials satisfied of the validity of the recognition, but the insurance company also. The photographs were compared by certainly ten persons, and declared to be those of the same individual. Yet all were mistaken. Another case equally singular happened about the same time. It occurred in connection with the Halliday murder in this State. The bodies of two women found in the Halliday barn were first identified as those of Halliday's daughter and granddaughter, although not without some difference of opinion on the part of the relatives, as the two sons of Halliday denied that the bodies were those of their sister and niece, while other relatives were just as positive that they were. Within twenty-four hours the bodies were identified again as those of a certain Margaret M'Quillan and her daughter, by a second set of relatives equally positive. All this happened before decomposition had become sufficiently far advanced to account for the errors.

Cases like these, where the nearest relatives of an individual have been mistaken in the identity of a corpse, should sufficiently emphasize the care which it is requisite for the medical examiner to exercise in that part of the external examination which is intended to establish or confirm the question of the identity of the corpse. To this end, after noting the appearance of the body with regard to blood-stains, extraneous dirt, etc., it should be carefully washed. This is necessary not only to facilitate the inspection for the purpose of establishing identity, but also to prevent the drawing of erroneous conclusions from superficial appearances. Strange as it may seem, the stains produced by ingrained dirt have been mistaken for the marks of commencing decomposition, also for contusions. The external examination should commence with the head, and be completed in an orderly manner. The special external details necessary for establishing identity are treated of in another article. If the identity of the body is beyond dispute, many of the details of the external examination, as far as this relates to identification, may in the discretion of the examiner be omitted, always bearing in mind, however, the fact that certain questions may be settled at this time which, arising later, when decomposition has advanced, cannot be answered. It is better in a doubtful case to be over-particular than to regret an omission when it is too late to remedy it.

The body should now be examined for contusions, recent fractures, and external wounds. The region of the scalp should be particularly observed, for extensive ecchymoses are frequently found in this locality, especially on the lateral and posterior surface of the head, and not necessarily associated with fracture of the skull. Sometimes they cannot be seen until the scalp has been retracted, previous to the removal of the calvarium. If this is done at this juncture for the purpose of determining the existence of a suspected ecchymosis, the brain should be left *in situ*. In general, it is better to defer the removal of the calvarium until the examiner is ready to proceed with the inspection of the brain. The region of the neck should always be examined for finger-marks and the lividities produced by throttling. Other evidences of violence about the neck, such as the circular or oblique marks left by a cord, are to be noted and described; if multiple, this fact should be particularly mentioned. Some writers regard this as proof that death was homicidal and not self-inflicted. When wounds of the neck are present, their direction should be carefully observed, also their extent and number. Suicidal wounds made by a right-handed person run from left to right, while homicidal wounds take the opposite direction. The so-called tentative wounds of the suicide are to be noted.

As the court must depend upon the medical examiner for a description of the wounds, their nature, direction, etc., the matter is here briefly mentioned. In making the external examination of wounds, the most important question with regard to determining the manner of their infliction is that of direction. In describing a wound this is the first and most important detail. With a view of determining the character of the weapon, the peculiarities of the wound are next to be described, whether incised, lacerated, or contused. With regard to wounds with clean-cut edges, the examiner is cautioned against hastily calling them incised, particularly when on the scalp, where a blow from a bludgeon may produce a wound having all the characteristics of that inflicted by a cutting instrument. In penetrating wounds extreme care

should be exercised in the use of the probe, lest the examiner be accused of producing, for instance, a puncture of the intestine, or some other such injury. It is to be kept in mind that the lawyers for the defense will look not for a probable but for any possible circumstance, no matter how remote, which may exculpate their client or throw doubt on his conviction. It is better, therefore, to use the probe simply to determine the direction of a wound, and leave the question of extent to a subsequent dissection to decide. Of course the dimensions of all external wounds require mention. In mentioning their situation the measurements should always be taken from fixed bony points.

The question whether a wound has been inflicted before or after death is more fully treated in another article. It is sufficient to suggest here that the edges of wounds be examined for retraction, ecchymosis, swelling, and the depths for clotted blood. These circumstances all point to a wound inflicted during life. If pus be found, or other evidences of inflammation, this should be mentioned, as it is evident that the person must have survived the infliction of the wound some time. The examiner should not be content with a superficial description of a wound. He should state exactly what vessels have been divided, what large nerves and other important structures. Foreign bodies should always be looked for, and if found, their location stated. The hands, especially on their palmar surfaces, should be examined for cuts. In cases of homicide there are almost always marks of injury in this situation, particularly if the assault has been committed with a cutting instrument. The external examination of the body may be completed by an inspection of the natural orifices. The mouth and pharynx should be examined for the evidences of the action of corrosive poisons, such as the mineral acids or oxalic acid. In cases where death has resulted from strangulation the mouth and nostrils are often filled with a bloody froth, the tongue and lips swollen. These appearances are to be noted. Sometimes, also, evidences of disease may be seen in this locality, as, for instance, the scars of syphilitic ulcers, or possibly the mucous patches of active disease. So, too, the scarred tongue of epilepsy may be made to tell its story. The pharynx should be inspected for foreign bodies, and such portions of the upper air-passage as are accessible to external examination. The more complete inspection of the larynx and trachea must be deferred until the internal examination of the body. The external auditory meatus on each side is to be inspected for traces of hemorrhage; so with the nasal passages.

The information which is to be gained from an examination of the male genitalia is not usually of much importance, other than as bearing on the subject of identity. In the case of a female, the examination of the vagina and external genitalia is of great importance. The lacerations and injuries which are inflicted on these parts in criminal assaults are often very great, and cannot easily be overlooked. In the case of women who have borne children, or who have been accustomed to sexual intercourse, an assault may have been perpetrated without the infliction of any injury on the genitalia. In such a case the vaginal mucus may be withdrawn on a piece of surgeon's gauze and preserved in a test-tube for subsequent examination by the microscope. In this way the crime of rape may be detected, which otherwise might have escaped notice from the uninjured condition of the pudenda.

It is often of importance to be able to determine the length of time

which has elapsed since death. To facilitate such an estimate, we may divide the period after death into three divisions: first, that period during which the body is cooling, but prior to the inception of rigidity; second, the period of rigidity; third, when rigidity has disappeared and putrefaction has commenced. It is not possible to draw any distinct boundaries between these different epochs, because there are many circumstances which modify both the time of their inception and their duration. These will be treated of in another chapter. With regard to temperature, it may be stated that if a body has an external temperature of 80° F. or over, death has occurred, probably, within four hours. In deaths from certain diseases, such as cholera, hydrophobia, tetanus, in strychnine poisoning, the temperature rises after death. The latter case is the only one likely to be a cause of error to the medical jurist. For the purpose of taking the temperature of the dead body, any surface-thermometer may be used, such as Seguin's or that of Immisch. The instrument is placed on the abdomen, and a reading is taken after it has been in position at least fifteen minutes. The rigidity which occurs after death, the so-called rigor mortis, does not as a rule come on until from two to three hours after death, and *in previously healthy persons dying suddenly*, not for some hours later. In such a case as the last mentioned, which is that most likely to come under the notice of the medical jurist, if rigor mortis be well marked death has almost certainly occurred at least six hours previously, and possibly twelve hours may have elapsed since death occurred. In the temperate zone putrefactive changes do not appear, unless under exceptional circumstances, until the end of the second day after decease. In death from septic disease putrefaction commences much earlier, but these cases are not of that class in which it is necessary to estimate the period which has elapsed since death. Such a necessity arises usually where the person deceased has previously been in perfect health, and has perished by violence. This consideration will enable the medical examiner to make reasonable and fairly positive assertions with regard to the inferences to be drawn from the appearance of putrefactive changes in such cases, unless the post-mortem examination reveals pathological conditions which compel him to make reservations. Thus it can be said that if a body show the characteristic discoloration of the abdomen together with lividity of the dependent parts, death has occurred at least forty-eight hours previously, if the season be summer; while in the winter from seventy-two to one hundred and twenty hours will elapse before the appearance of the characteristic discolorations. As all such questions as these are likely to come up in a medico-legal inquiry, it has been thought best to refer to them in connection with the external examination of the body. They will be found in another chapter, where they are treated at length.

In the inspection of the body for injuries such as contusions, etc., there is one precaution to be observed: the petechiæ of decomposition should not be mistaken for the extravasations of contusions. A curious instance in which this error was committed lately came to the writer's notice. A young man of dissipated habits in a fit of despondency committed suicide by taking laudanum. The ambulance surgeon who was called to the case found him dead on arrival, and after examining the body returned to the hospital. The friends of the young man lived in a distant city, and after the coroner's inquest the body was sent to them.

Some days thereafter an indignant communication came to the hospital, in which it was charged that the young man had been the victim of foul play, owing to the fact that the body was "covered with bruises when received." As a matter of fact, there was no truth in the suspicions of the relatives. It appears that they were quite ignorant of the vicious habits of the deceased, and had mistaken the petechiæ of decomposition for contusions. There were, however, a number of witnesses to the circumstances of the young man's death, and the mistake resulted in no harm. It is easy to see, however, how very serious might be the results of such a blunder. To make the distinction between the ecchymoses resulting from violence and the lividities of decomposition is not difficult. In the first place, the ecchymosis is a true hemorrhage, which the lividity is not; therefore an incision into the former will either be followed by the escape of the effused blood, or, what is more common, a subcutaneous clot will be found. Post-mortem lividities are displaced by pressure of the fingers; ecchymoses are not. That an actual hemorrhage ever occurs after incision must be quite exceptional, and can only happen when for some reason the blood retains its fluidity long after death. In the post-mortem lividity, the incision is not followed by the escape of blood, nor is there any clot present. The position of the spots is significant. When of post-mortem origin, they are found on the most dependent portions of the body, such as the calves of the legs, the posterior parts of the arms. The sides of the chest posteriorly are almost always the seat of these post-mortem discolorations, which, as they extend downward, coalesce until the back presents the appearance of a uniform suggillation. The time at which the discoloration appears is of some importance, post-mortem spots not appearing until an interval of some hours after death. No exact time can be fixed, however, for their appearance, as this varies according to climate, season, cause of death, as well as for other reasons at present unknown. Of course, if the injury which caused the discoloration occurred some time before death, swelling may be found in the vicinity, and the ecchymotic spot will be elevated above the surrounding surface—something which never happens in a post-mortem spot. So also the color of the ecchymosis may be characteristic, if time sufficient shall have elapsed before death for the familiar changes to occur. No such changes take place in the petechiæ of decomposition. When decomposition is far advanced, the difficulty of distinguishing between the ecchymosis and the spots of decomposition increases greatly. It is impossible to say at what period it becomes impossible to make the distinction. This is a matter which must be left to the discretion of the examiner. It is very doubtful whether such a distinction should be attempted after the skin is far advanced in decomposition.

Internal Examination.—The technique of an autopsy is very different from that of a dissection. The broad and vigorous sweep of the knife with which the incisions are made to expose the viscera is very different from the cuts of the dissecting-scalpel. As Virchow remarks in his work on post-mortem examinations, fine work may occasionally be required for pathological anatomy, yet it is not the rule. It may be further stated that in the majority of medico-legal inspections it is still more exceptional for the necessity for fine dissections to occur. The ordinary dissecting-case is therefore not well adapted for the purposes of an autopsy. The incisions in the soft parts are of two kinds: first, that

which exposes the cavities of the body, for which purpose a rather broad but short and stout knife is used, fitted into a thick and broad handle; second, incisions into the viscera themselves. For the purpose of avoiding a number of short cuts, which should never be made, a knife should be used as long as an ordinary amputating-knife, but with broader blade, for making sections of the brain and the larger viscera at one sweep. The object in making these sections of the viscera in this manner is to expose a broad and even surface for examination without tearing the tissues, and this can only be done with a long and rather broad knife. For finer dissections an ordinary scalpel may be used. The blade of the first knife should be about three and a half inches long by one inch in breadth, with a handle four inches in length. The long-section knife should have a length of eight and a half inches, a breadth of one and a quarter inches. Other instruments which are of use in the autopsy are a saw, a hammer with hooked handle for removing the calvarium, a saw slightly curved for exposing the spinal cord, a costotome for dividing the ribs when ossified, and an enterotome for slitting the intestines or trachea. A few probes of different lengths, the chain and hooks of the dissecting-room, and a blow-pipe complete the necessary appliances of the post-mortem table. A brass gauge marked in millimeters is sometimes used for the purpose of making such measurements as the thickness of the ventricular walls, etc. A pair of small scissors having one blade pointed, the other probe-pointed, is often of use in laying open a small duct like the common bile-duct, but the necessity for such an examination seldom occurs to the medical jurist. Where the weight of the viscera is likely to be of importance, a pair of scales is a necessity. For the purpose of estimating the amount of fluid found in a large cavity, such as the chest, a large sponge is useful with which to remove the fluid, which is afterward expressed into a vessel of suitable size and measured in a graduate provided for the purpose.

Usually no autopsy ought to be performed earlier than twelve hours after death, except in cases where death has resulted from violence, and the German regulations do not permit an autopsy until twenty-four hours after. Even in cases of death by violence it is questionable whether an earlier examination is advisable, for it is possible to make the external examination as early as necessary, deferring the autopsy proper to the usual time after death. The Bishop case will no doubt occur to the reader as an instance where neglect of this precaution was the cause of great annoyance to the examiners, who were even indicted for their precipitation in hastening the autopsy. Yet it was because of their fear that post-mortem changes would obscure the peculiar condition which they sought in the nervous system, that they hurried the autopsy, with most unpleasant results to themselves. However desirable an early examination may be, considerations of humanity and obvious expediency will induce the examiner to defer the dissection until the lapse of at least twelve hours and possibly a full day after death. It is essential that an autopsy should not be held by artificial light. Differences in color, particularly such as denote the existence of pathological changes in the nervous system, are not easily appreciated except by daylight. Frozen bodies should be thawed out in a warm room, but the thawing process ought never to be hastened by artificial means.

In corpses other than those of new-born infants, the order in which

the examination should be made is as follows: first, the brain and cranial cavity; second, the vertebral column and spinal cord; third, the thorax; and lastly, the abdomen. The skull is to be exposed by an incision through the scalp made from ear to ear, over the vertex. The two flaps are then reflected anteriorly and posteriorly sufficiently to give room to saw through the calvarium. Any ecchymoses not before visible are now to be noted, and the surface of the cranial vault examined for fractures. If found, they should be traced throughout their whole extent, especially when, as is often the case, they extend into the base. In this situation they can be more conveniently followed after the calvarium has been removed. For this purpose usually it is directed that the saw-cut be made in a perfectly circular manner around the skull. There is one disadvantage connected with this method, which is, that when the calvarium is replaced, as the cut surfaces are horizontal, it is easy for them to glide apart. Thus an unsightly ridge or depression may be left over the forehead, marking the edge of the sawn bone, after the soft parts have been drawn together and the body prepared for burial. As it is desirable to conceal all traces of the autopsy subsequently, when possible, a modification of the usual method of applying the saw is here suggested. Instead of the circular cut around the cranium, two saw-cuts are made, one on each side of the skull, commencing anteriorly in the median line just above the superciliary ridge, running backward and terminating one inch above the external auditory meatus. Commencing a little below the "lambda," two other similarly oblique cuts are made, which join the first at their termination. The calvarium may now be removed. The dura should be cut through if adherent. The calvarium should never be violently torn off, for fear of injuring the brain. It will be seen that when replaced the obliquity of the saw-cuts prevents the calvarium from sliding in either direction. An ingenious method of still further securing the calvarium when replaced is practiced at the Methodist Episcopal Hospital of Brooklyn. In each of the anterior cuts, a little in front of their termination, a second saw-cut two inches long is made, parallel to the zygoma. Into these short cuts a two-inch roller is passed directly through the skull from side to side. The calvarium is then replaced and the ends of the roller bought together over the vertex and pinned. This renders it impossible for the calvarium to be subsequently moved. The temporal fascia should also be sutured before the scalp is replaced. (Fig. 1.)

After the removal of the calvarium its interior is to be examined with regard to the condition of the internal table, extensive shattering of which may exist without corresponding injuries of the external table. The dura mater is then to be inspected and its condition noted. Extra-dural clots are to be turned out into a graduate and *measured*—which is more exact than to make the usual loose statements, "a quantity of clotted blood," "a large clot." The meningeal arteries are to be carefully examined, especially where extra-dural clot exists, as they are frequently the seat of the hemorrhage. The longitudinal sinus may then be slit up and examined, after which the dura is to be divided and the arachnoid and pia inspected. Particular attention is to be given to the membranes with reference to the existence of such conditions as lepto- or pachymeningitis. The explanation of many an act of violence may often be found in just such pathological changes. The vascularity of the membranes is also to be noted. After this the brain is to be removed, the

section of the cord being made by a long knife, as low down as possible, to secure the whole of the medulla for examination with the brain. The base of the skull is now accessible for examination after removal of the dura which lines it. The sinuses of the base can also be inspected.

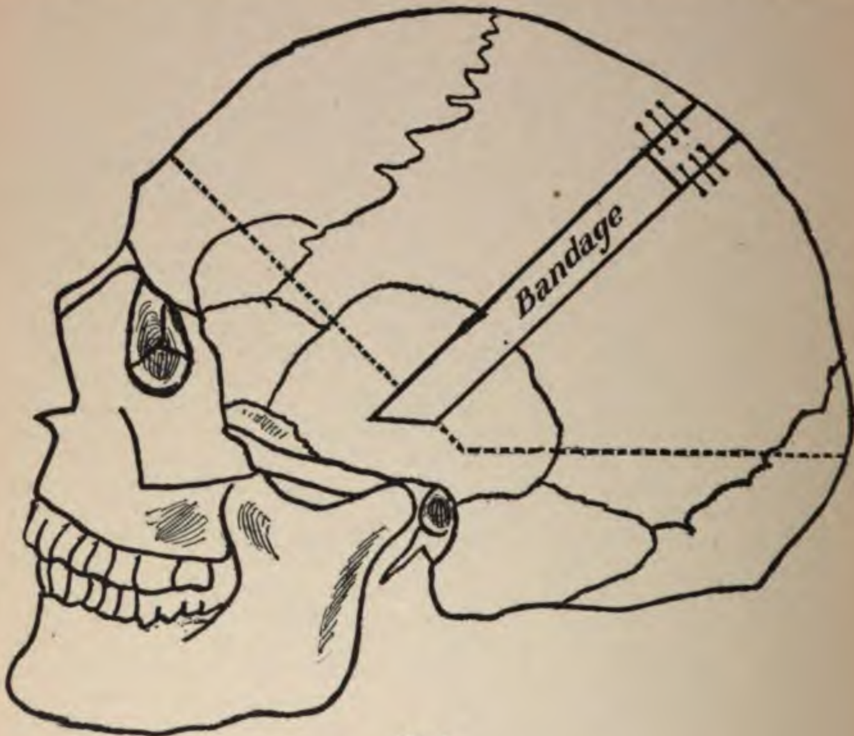

Fig. 1.

The brain should then be weighed. The circle of Willis is then to be examined for miliary aneurism, emboli, etc., and also the middle cerebrals, so frequently the seat of disease. In cases of suspected poisoning by narcotics, particular attention is to be given to the state of the membranes, the sinuses, and the intra-cerebral circulation. In poisoning by opium the veins are said by some to show a slightly deeper color than the arteries. This seems doubtful in view of the imperfect aëration of the blood which occurs in these cases. At any rate, this disappears after exposure to the air, as both veins and arteries soon take up oxygen and become of uniform color. In estimating the amount of congestion present in the vessels of the central nervous system, it is never to be forgotten that the injection of an embalming fluid, particularly where a vein has not been opened and the vascular system washed out previous to the injection of the preservative fluid, is perfectly competent to produce an appearance which it is difficult to distinguish from the extreme congestion of narcotic poisoning or other pathological congestions. There will be found the same arborescence, the same punctate appearance

of the white matter on section, the same turgescence of the choroid plexuses. The coloration of arteries and veins will be uniform, however. In the Harris case the defense, singularly enough, overlooked this obvious point, for the body of Mrs. Harris had been embalmed previous to burial. In this connection it is also of some importance to remember that undertakers use for this purpose a small force-pump, and that as the fluid is forced through the vessels it takes up the coloring matter of the blood and produces the appearance above referred to. The writer has verified this statement many times in the dissecting-room. The more dependent portions of the brain are also apt to have a congested appearance even when no injection has been made, simply from the gravitation of fluids. The fact that the congested appearance is restricted to the more dependent parts will prevent this condition from being mistaken for true congestion.

The dissection of the brain is next in order. To make proper sections here, it is imperative that the knife used should be as keen as possible. The cut through the hemisphere should be made with a quick drawing motion with the minimum of pressure, otherwise the soft nervous tissue will certainly be torn as the knife drags and tears its way through. It has been recommended by Virchow that the incisions should commence from within and terminate at the pia mater, which is not, however, divided, but serves as a binding to keep the various sections together in proper serial order. In this manner the relations of the divided structures are preserved, and it is possible to reëxamine them in their natural order, if desirable. With regard to the thickness and number of the sections necessary, it may be observed that in cases where it is likely that the condition of the brain will form an important part of the case, it is easy to make too few sections, impossible to make too many. In sections half an inch thick many a spot of softening or small hemorrhage may lurk concealed. This is particularly true of the "pons" and medulla, where very small lesions may be the cause of very formidable symptoms. It is in this particular part of the brain, therefore, that the sections should be most numerous, perhaps even microscopic. It is recommended that the first sections be made from within the great longitudinal fissure outward serially until the level of the corpus callosum is reached. At this point the lateral ventricles are to be opened by two incisions a quarter of an inch on either side of the raphe. The cavity of the ventricle once found, the rest of the ventricle may be exposed by cutting through the roof with the probe-pointed scissors, following the floor with the probe blade. The presence or absence of serum in the ventricular cavity is to be noted, and its quantity, if present. For the purpose of measuring the contained fluid, it may be withdrawn from the cavity of the ventricle by the aid of a small syringe, and measured in a graduate. Some writers recommend that the ventricles be opened first before any other incisions are made in the brain, lest the manipulations necessary for the other incisions should so lacerate the substance of the brain as to permit the escape of fluid. It is difficult to see how a satisfactory dissection of the ventricles is possible without removing so much of the cerebral lobes as to bring the cut surface on a level with the corpus callosum which forms the ventricular roof. It is evident, however, that the utmost care is needed to prevent the occurrence of lacerations in handling so soft a tissue as that of the brain. The most important parts

to be examined in the ventricles are the choroid plexuses. After ascertaining their condition, the pillars of the fornix are to be divided and reflected, when the velum interpositum will come into view, with the veins of Galen. The state of the vessels in this tissue is to be noted, after which the velum is to be reflected, and the cavity of the third ventricle may be then inspected, together with the corpora quadrigemina, the geniculate bodies, and the iter.

With regard to the further dissection of the brain, which involves the making both of macroscopic and microscopic sections, it has already been stated that the examiner, in a certain class of cases, is more likely to make too few than too many. Indeed, the only limit which can be placed on the number of the sections to be made in cases like that of Harris or Buchanan is that which time imposes. In ordinary instances, sections of the convolutions made at intervals of half a centimeter will usually be sufficiently close, although it is quite possible, as before stated, for small foci of softening to lie concealed in sections of this thickness. Much must be left to the judgment of the examiner in each individual case with regard to the thickness and number of the sections. Virchow's remark in this connection is significant: "The less you find, the greater ought to be the number of the sections." Microscopic sections will rarely, if ever, be required in any number save in the regions of the medulla and pons. Where these are required, the examiner may remove the parts mentioned and preserve them in alcohol for the subsequent microscopical examination. In the examination of the internal capsule, particular attention should be given to that portion supplied by Charcot's artery of hemorrhage, the lenticulo-striate artery. This is a branch of the middle cerebral, which, passing through a separate hole in the anterior perforated space, runs upward between the lenticular nucleus and the external capsule, then perforates the internal capsule, terminating in the caudate nucleus. In the dissection of the basal ganglia the incisions should be made radially in an antero-posterior direction, converging toward the peduncle.

The floor of the fourth ventricle should be inspected for the petechial hemorrhages, which are of quite frequent occurrence in this vicinity. In cases where fracture of the skull has occurred they are not uncommon, and are probably the result of concussion. The writer has also seen them in cases of death from opium poisoning, and from gunshot wound of frontal lobe. In one case they were in the pneumogastric nucleus, on each side. It has been shown that they also are found in this vicinity in criminals who have been put to death by electricity.

The examination of the spinal cord is next in order. There is no part of the autopsy which should be conducted with more care. It has been conclusively shown by Van Giesen that injuries may be inflicted on the cord by rough handling during its removal, which may simulate softening, displacement of both gray and white matter, etc. For a complete account of the various injuries which may be inflicted on the cord in process of removal, the reader is referred to the original paper, which appeared in the New York *Medical Journal*, June, 1892, "A Study of the Artefacts of the Nervous System." The conclusions which the writer draws which are to be noted in describing the technique of the removal of the cord from its bony canal, are as follows: The use of mallet and chisel is inadmissible for the purpose of cutting through the laminæ of

the vertebræ, because it is easy by this method to force in upon the dura and cord fragments of bone, which will surely produce a bruise. The blows of the mallet are of themselves quite sufficient to produce effects which may be mistaken for pathological changes. The use of heavy bone shears is equally to be deprecated, as the introduction of the inferior blade into the vertebral canal is almost certain to result in a contusion of the cord. The double-bladed saw is objectionable because it is liable to jam in the saw-cut, and the violence which is necessary to release the blades may thrust them into the vertebral canal and injure the cord. The chisels of Brunetti, used in removing the cord through the abdominal incision by chopping through the pedicles, while expeditious, are, according to Van Giesen, as objectionable as the use of the chisel in the ordinary manner. Of all the different methods employed for the purpose, Van Giesen considers that the use of the chisel is most likely to result in the production of artefacts. He recommends the use of a single saw "slightly curved or gently rounded at the point." With this saw the vertebral archway is to be *completely* severed on both sides of the spinous processes, due care being exercised not to drive the saw into the vertebral canal so as to injure the cord. Prior to the use of the saw, the soft parts will have been retracted, and the vertebræ, especially those in the cervical region, carefully inspected for fracture. After finishing with the saw, the spines are to be gently tested with the hand, and if any are found immovable the saw is to be reapplied until the arches have been completely severed. On no account is the hook or chisel to be used to release a partly divided arch, as this is sure to result in bruising the cord. The bone shears are also to be avoided. With regard to Dr. Van Giesen's criticisms on the use of the two-bladed saw, it may be observed that this instrument is at present used by the best pathologists in Europe, and that the single saw may be made to lock in the saw cut, just as the double blade. The older instrument furnishes the readiest means of exposing the spinal canal, and if used carefully ought not to result in the production of artefacts. After the removal of the posterior vertebral archway, the cord is to be taken out of the vertebral canal in its dural sheath, any epidural hemorrhage being noted. While dividing the attachments of the dura, the spinal nerves, etc., care is to be taken not to handle the cord itself. It is safest to remove the cord from its canal by taking hold of the dura with forceps and lifting it out in this way, taking care neither to stretch nor twist it. As the examination of the cord will usually be made by the aid of microscopic sections, it must be taken to a distance for this purpose, and in order to avoid injury should be carefully placed on a bed of soft cotton and covered with alcohol. It may be divided into a convenient number of sections for this purpose. Van Giesen relates a case where a cord was taken across the city resting on a bed of pounded ice. The cord settled down in the ice in transit, and bruises occurred. In this case the cord was already very vulnerable because of an acute myelitis. Where the cord has been transported in its dural sheath, the examination of the subdural space for hemorrhages, clots, etc., must be left for the microscopist, or the examiner may himself be present when the dura is opened, in order to inspect its interior. The practical point for the medical examiner to bear in mind with regard to the spinal cord is the ease with which artificial injuries, inflicted either in process of removal or transportation, may be mistaken

for injuries incurred before death. The importance of this fact to the medical jurist cannot be overrated.

The incision for exposing the cavities of the thorax and abdomen, as usually made, commences at the episternal notch and terminates at the symphysis. It should be firm, deep, and pass to the left of the umbilicus to avoid the round ligament of the liver. In extending the incision through the peritoneum, the recti muscles may be severed at their pubic attachments. This will be found convenient, especially if rigor mortis is well developed and the muscles large. As in medico-legal autopsies it frequently becomes necessary to examine the trachea, pharynx, and œsophagus, it is better to commence the incision at the chin and complete it as usual. This is the present German method. It exposes the region of the neck, and renders it possible to remove the larynx, trachea, and œsophagus. The two former structures will always require examination in cases bearing marks of violence in the neck, as from strangulation or suspension. Sometimes, in cases where the body has been found face downward in a shallow pool of water, an examination of the pharynx and trachea will show, by the presence of water, sand, or weeds, that efforts at respiration had taken place after immersion of the mouth; and such evidence would tend to the conclusion that the deceased met death by drowning, or at least that when he fell into the pool he was alive. Where there is reason to expect fracture of the trachea or larynx, it has been advised that the structures should be opened from behind, and examined after removal. In those instances where corrosive poisons have been taken, the examination of the œsophagus will show the action of the drug. If the examination of the trachea and larynx reveal reddening and œdema, it should not be forgotten that these structures are almost the first to undergo putrefaction, of which the reddening and œdema may be but signs. In the somewhat rare cases where a foreign body has lodged in the œsophagus, and, as in a case seen some years ago by the writer, caused ulceration into the aorta and sudden death from rapid hemorrhage, an examination of the œsophagus will be necessary in order to show the cause of death; also in death from corrosive poisons.

In order to expose the thorax, it is, of course, necessary to reflect the soft parts to a point beyond the cartilages of the ribs. This may be most conveniently done with the short, broad knife. In the abdominal region, the primary incision may extend quite down to the peritoneum; but as such a *tour de force* can only be accomplished after much practice, it is better to make several incisions through the abdominal wall, than by one ill-judged slash of the knife to wound the intestines. When the peritoneum is reached, it may be opened by passing two fingers into a narrow opening made for the purpose, and then slitting it up between the fingers as a guide. The abdomen is to be opened and *inspected* first, but the contained viscera must not be dissected or removed until after the examination of the thorax, because the division of the large vessels of the abdominal viscera would certainly drain the blood from the cavities of the heart, and render it impossible to state with precision their condition with regard to contained blood. So too, if, on the other hand, the thorax be opened first, it will be impossible to determine the position of the diaphragm—a point of some importance in autopsies on the bodies of new-born infants. The inspection of the abdomen should therefore be made with a view to determining the position of the diaphragm with regard to

the ribs, the color of the contained parts, and, where this can be ascertained without dissection, the presence and position of any foreign body. With regard to the latter consideration, it may be observed that the search for a missile in the abdominal cavity is always a matter of difficulty, as witness the autopsy in the Garfield case, where the bullet was not found in the abdomen at all, although most careful search was made for it, but was afterward discovered in the vessel which had been made the receptacle of the removed viscera. It will therefore be necessary in these cases to defer the search for the foreign body until the dissection of the abdomen. The presence of fecal matter from wounds of the intestine, of clotted blood or of serum, may be ascertained at this point. Blood-clots should be transferred to a graduated vessel and thus measured, so that an exact statement of the amount of clot may be made in the report in place of the usual inaccurate wording, "a large amount of clot," etc. The quantity of blood-clots or other fluids in the cavities of the body may also be determined by weight. Serum may best be measured by sopping it up with a large moist sponge and expressing it into a suitable vessel, until the cavity is dry. The color of the abdominal contents ought to be ascertained soon after opening the cavity, as, owing to absorption of oxygen, they quickly change from a dusky red to a deep red, which may and often is mistaken for the signs of an inflammation. It may be further remarked that bright red arterial blood is never found in the dead body. (Virchow.) The more dependent parts of the abdominal viscera always assume a deeper red than those which are uppermost, and this fact will assist the examiner in determining whether the color is due to inflammation or not. If confined to the dependent parts, it is certainly the result of the gravitation of the blood; whereas if uniform, particularly if the peritoneum have lost its gloss, it is probably due to irritation or inflammation. Old adhesions, thickenings of peritoneum, and other signs of past inflammation are to be noted.

The preliminary inspection of the abdominal cavity having been completed, the thorax may now be opened. One precaution is to be observed in this connection. After the costal cartilages have been divided close to the ribs, in disarticulating the sternum from the clavicle particular care is to be taken not to wound the great veins beneath, as is often done. Where this happens, it is impossible to determine whether the blood which is certain to be found in the chest is the result of the wounding of the veins, or, if there is a wound of the chest, to determine what proportion of the effused blood is due to the previous injury and what to the divided veins. If the crescentic shape of the sterno-clavicular articulation be borne in mind, the separation of the articular surfaces will be facilitated if the examiner direct the knife in such a manner as to follow the curve. The cartilage of the first rib is frequently ossified, and it is here that the greatest care must be exercised, else the knife or costotome will wound the vessels beneath. In the first place, it is to be remembered that the cartilage of the first rib extends about half an inch further outward than that of the second, consequently the incision must be made with this in mind, else the knife will come in contact with the manubrium. If the knife is placed under the rib and the cut is made in a forward direction, the vessels will be avoided. After dividing the sternal attachments of the diaphragm, the entire sternum may be removed or reflected and the pleural cavities examined. Any fluid, as serum or blood, is care-

fully to be removed with the sponge and expressed into a vessel, and measured or weighed. The presence of adhesions is to be noted, and other evidences of recent or chronic disease which appear on the surface of the lungs. The mediastinum is also to be inspected. The pericardium is then to be opened carefully so as to prevent the escape of any fluid therein contained, which is to be measured as before directed. Both its visceral and parietal surfaces are to be inspected for pathological changes.

With regard to the external appearance of the heart, an important point is the condition of the coronary arteries. After the removal of the heart, their caliber should be tested, after which they should be slit and their interior examined for atheroma, etc. Many a case of sudden death may be explained by an inspection of the coronary arteries, one of which may be found to be almost or quite occluded by a thrombus, which has rapidly formed about an atheromatous plate stripped up by the blood current. If the heart be now removed from the thorax, much of the blood in the auricles may escape, and an exact estimate of the blood in the heart rendered impossible. It may be objected that such exactitude is unnecessary. In a medico-legal inquiry it is impossible to be too exact, as the result of many a trial has shown, to the mortification of the too confident medical witness. The auricles and ventricles are therefore to be opened in the manner about to be described, and their contents examined both with regard to color, quantity, and general appearance. Ante-mortem clots will be evidenced by their extreme pallor and toughness, also the fact that their centers are disintegrated. Pale yellow and succulent clots are of no significance, as they may be formed in the last moments of life, whatever the cause of death. (Delafield.) The heart should be opened in such a manner as to expose the cavities and valves without injuring the latter. The dissection of the heart consists of two stages. The first stage includes the opening of the auricles and ventricles, the heart being *in situ*, and the subsequent estimation of the clots and the measurement of the auriculo-ventricular openings. The second stage consists in the removal of the heart and the examination of its valves and interior. The right auricle should be opened first. The incision should commence between the two venæ cavæ and end in front of the base. (Fig. 2.) The clot should then be turned out into the pericardium, from whence it may be removed for estimation by weight or measure. If measured, an ordinary glass graduate may be used. The approximated index or middle fingers of the left hand may then be introduced through the tricuspid valve into the right ventricle, the walls of which must be gently separated. If the auriculo-ventricular opening permits the introduction of these fingers, especially if the fingers be thick, the lumen of the valve may be considered normal. In the case of slender fingers, it is possible to introduce between the index and middle fingers of the left hand the index finger of the right. After the size of the opening has been ascertained the incision into the right ventricle should be made. This should commence close to the base, pass into the ventricle, and end just short of the apex. The septum must be avoided. In the case of each cavity, the clot is to be turned out as before directed and measured. The incision for the left auricle commences at the left pulmonary vein and ends in front of the base, avoiding the coronary veins. The incision into the left ventricle begins behind the base and is carried down toward the apex, which it must not quite reach. The measurement of the valves and clot is con-

PLATE II.

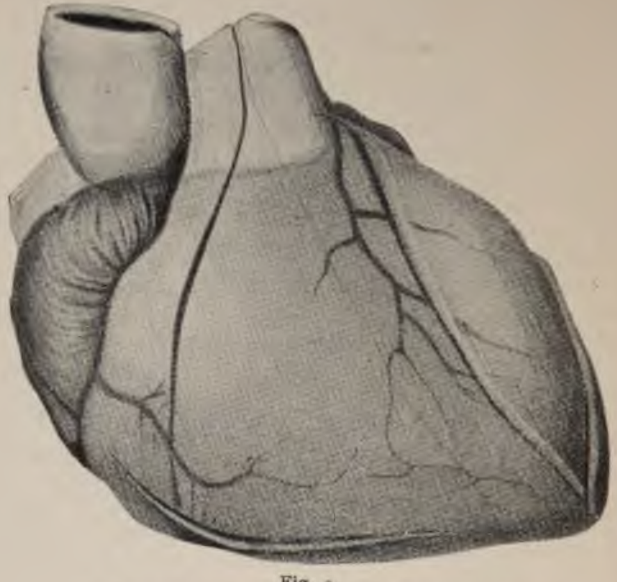

Fig. 2.
LINE OF EXTERNAL INCISION OF HEART.
(VIRCHOW.)

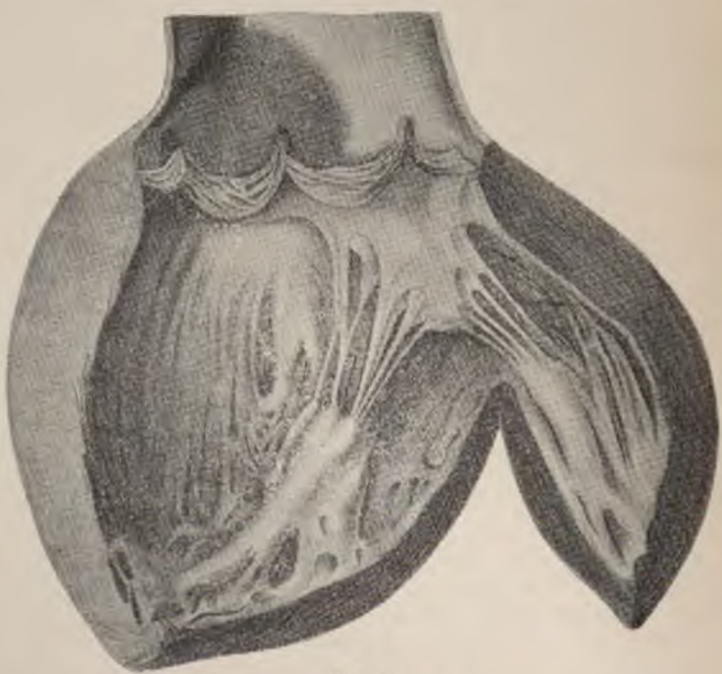

Fig. 3.
EXPOSURE OF INTERIOR OF HEART.
(VIRCHOW.)

tinued as before. The heart may now be removed, taking care to cut all the vessels rather long. The sufficiency of the aortic and pulmonary valves may now be tested by pouring water into these vessels. For this purpose the heart must be suspended by the vessel the valves of which are the subject of the test. It is important that the suspension is made in such a manner as to preserve as far as possible the circular form of the artery. This may be done either by passing a number of sutures through its walls or by grasping its walls with the fingers of both hands in such a manner as to preserve its shape. No lateral traction should be made. The real efficiency of the water test may be called in question, for it may be doubted whether the integrity of the valves may not be better determined by inspection and touch. The ventricles may now be fully opened for the purpose of examining the flaps of the auriculo-ventricular valves, the endocardium, and other structures in the interior of the heart. (Fig. 3.) The incision for the right ventricle (Fig. 2) is made by entering a pair of scissors into the previous incision and carrying it toward the pulmonary artery, avoiding the anterior papillary muscle by passing in front of it. The incision for the left ventricle (Fig. 3) is made in a straight line, prolonged from the aorta, close to the septum. This incision must not cross the pulmonary orifice, as it will if carried too close to the septum, nor must it cut that portion of the mitral valve which is attached to the left border of the aorta by going too far to the left. The incision should pass midway between the pulmonary orifice and the left auricle.

The examination of the heart being completed, the lungs may now be removed. This is done by seizing each lung in turn, lifting it up, and dividing the vessels at the base. The bronchi should now be opened with a pair of scissors, and examined for foreign bodies and morbid appearances, commencing with the primary bronchi and following them up to their subdivisions as far as necessary. The lung tissue itself is to be examined, by means of long incisions made with sweeping strokes of the knife, from apex to base, on the posterior aspect. The cut surfaces may then be inspected, and any fluid contained in the lung tissue or smaller bronchi expressed by passing the edge of the knife at right angles over the surface of the incision. Blood, pus, mucus, or serum may thus be squeezed out and examined. The presence of sanguinolent mucus in the air-tubes is significant.

The abdominal viscera are now to be dissected. In cases of gunshot wound of the abdomen, the intestines should be examined first; but in other cases it is best to leave them to the last, for the sake of cleanliness. Where it is necessary to search the intestinal canal for perforations resulting from gunshot wounds, it is best to do this in a methodical manner. The search may commence with the sigmoid flexure and rectum, thence extending to the three divisions of the colon, the intestines being passed through the fingers until the duodenum is reached. The location of all wounds, their number, and especially their position with regard to the wound in the parietes, are to be noted. In order to search for the bullet, it will be usually necessary to remove the intestines. This may be best accomplished by first ligaturing the gut both at the rectal and gastric ends with a double ligature, and then commencing at the rectum, dividing the mesentery until the whole intestine is freed from its attachments to the posterior abdominal wall. Further search for the missile may now be made, after the abdominal cavity has been thoroughly

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[illegible] the pelvis is [illegible] The [illegible] which are [illegible] The [illegible] inflam- [illegible] in a cer- [illegible] its cavity. [illegible] If any dis- [illegible] this will be [illegible] and endometrium

should receive attention, also the Fallopian tubes. The orifice of the tubes will not admit anything larger than a bristle, as a rule, and this can be passed most easily, after the uterus has been laid open so as to expose the cornua. The entrance to the Fallopian tube will be found in the apex of each cornu. In cases of abortion where death has occurred within a few days, the uterus must also be examined for signs of injury, as perforations, which would indicate the use of a pointed instrument—not necessarily, however, in the hands of another than the woman herself. The writer knew of two women, one of whom was accustomed to produce an abortion on herself by the aid of a lead-pencil, and the other used an umbrella wire for the same purpose, at last inflicting a fatal injury. The size of the uterus is of some importance in determining the period of pregnancy, where this has existed. The normal unimpregnated uterus measures two and a half inches in length, one and three quarters inches in breadth, and one inch thick. For further measurements as indicative of the period of pregnancy, the reader is referred to the appropriate chapter. In examining the uterus where death has taken place shortly after confinement, the observer ought not to forget that the site of the placenta presents appearances which may be mistaken for inflammation or even gangrene. The presence of pus, the condition of the uterine sinuses, the coexistence of peritonitis, and the presence of septic micro-organisms, possibly the streptococcus pyogenes, will make the distinction clear. One or all of these conditions will be found in acute inflammations of the uterus. The ovaries are usually involved in the morbid process, and will be found to be congested, swollen, and, where the disease has been of sufficient duration and acuteness, infiltrations and local abscesses may exist.

The examination of the stomach and duodenum is of special importance in cases of suspected poisoning. As the preservation of the contents is of prime importance, in order that this may be done without even the possibility of contamination, it is recommended that the stomach and duodenum be ligatured separately with double ligatures, and placed in new glass jars with glass tops, previously well washed in distilled water. The jars should then be sealed and at once sent to the analytical chemist. The examiner is to inspect the interior of both stomach and duodenum after the chemist has transferred their contents to suitable and well-washed vessels. It is better not to make this transfer in a room where chemicals are kept. The stomach may then be opened along its greater curvature, and its interior examined. This is a method which involves some extra trouble; but as the contents of these organs are not removed until they reach the laboratory which is their final destination, there is one less manipulation to call in question, and the risk of possible contamination is consequently lessened. Nor is such a precaution needless. Any one who is conversant with the refinements of modern chemistry and the history of past trials for poisoning will admit that any proceeding is proper which will limit the suspicions which a clever defense, aided by a friendly chemist, is able to cast on any chemical analysis, no matter how skillfully conducted. If the viscera have to be sent to a distance, another consideration must be taken account of, however, which is the cloud which putrefactive changes occurring in transit may cast on the analysis, by the production of ptomaïnes. This will occur particularly where the chemical analysis results in the discovery of some form of

alkaloidal poison, especially morphine. The Buchanan trial may be cited as an instance of the confusion in the expert chemical testimony which the presence of ptomaïnes occasioned. Indeed, in this case it may well be questioned whether the accused was not fairly entitled to the doubt which was raised when Professor Vaughan showed the similarity which existed between the reactions of morphine and indol. Certainly on the testimony alone of the chemists for the prosecution, the State was not entitled to a conviction. Where putrefactive changes are liable to occur in transit, it is better to transfer the contents of the stomach and duodenum to separate vessels. The viscera can then be immediately examined. With regard to the inspection of the mucous membrane of the stomach, it is to be remembered that post-mortem digestion commences at from twenty-four to thirty-six hours after death, causing softening and disintegration of the mucous membrane. This process is most active in the pouch of the greater curvature of the stomach, which may serve to distinguish this form of softening from that caused by disease. Occasionally when death takes place immediately after a full meal, during active digestion, the action of the gastric juice has produced a perforation of the stomach. Ulcers of the stomach occur, as a rule, at the pyloric end near the lesser curvature, although they may be found anywhere. They frequently have an indurated margin.

The examination of the liver is frequently of the utmost importance in medico-legal cases, as, for instance, to determine the existence of the changes which this organ undergoes as a result of certain poisons. So, too, in cases of death by extreme violence the autopsy may reveal extensive lacerations of the substance, even where the external signs of violence were absent. The liver may be removed for examination by first dividing the diaphragm on either side as far as the spinal column, then severing the lateral ligaments, the broad ligaments, after which it may be turned into the thorax, the vessels and coronary ligament divided, and the organ removed. If it seem necessary, the bile-duct must be examined previous to removal. For the purpose of inspecting the parenchyma, sweeping incisions may be made in the substance of the organ with the long knife. After the removal of the liver, it is possible to examine the posterior surface of the abdominal wall. The receptaculum chyli and lymphatic may be inspected with a view of determining, in certain cases, the relation of the time of death to the ingestion of food.

In the foregoing description of the method of conducting an autopsy, nothing has been said of the propriety of weighing the solid viscera. The utility of ascertaining their weight is doubtful, as this may vary within quite wide limits. Any conclusions based on the evidence of the scales ought for this reason to be accepted with caution. For the purpose of comparison, however, the following table is appended:

	Male.	*Female.*
Weight of brain	46–53 oz.	41–47 oz.
" lungs	1–37 of body-weight	1–43 of body-weight.
" heart	10 oz.	8 oz.
" liver	60 oz.	50 oz.
" spleen	7 oz. (average)	
" kidneys	4½–6 oz.	4–5½ oz.
" uterus		8–10 drs.

Examination of the Body of a Child.—The maturity of the child should first be determined. For this purpose its length and weight should be taken, also the length and condition of the hair on the scalp, the condition and length of the nails, the condition of the eyes with regard to the presence or absence of the membrana pupillaris; finally, the lower epiphysis of the femur is to be inspected with reference to the center of ossification. For this purpose a curved incision is to be made over the lower end of the femur, the patella removed, and the end of the bone protruded through the incision, when thin cross-sections may be made until the greatest diameter of the center is ascertained, which should be measured in millimeters. For the necessary measurements the reader is referred to the article on infanticide. The head must be examined for injuries, but the caput succedaneum formed during labor should not be mistaken for an ante-natal ecchymosis. The fontanelles should be inspected with care. There is a case on record where a midwife was convicted for the destruction of several children, which she accomplished by piercing the fontanelle before birth with a long pin. It is important to examine the neck for the marks of strangulation, but the ecchymosis left by an encircling umbilical cord which has strangled the child must not be mistaken for that which is the result of criminal strangulation. When this has been accomplished by the use of a soft ligature, it will be exceedingly difficult to make the distinction; but if a cord has been used, abrasions and excoriations of the skin will be found, and the mark will be narrower than that produced by the umbilical cord.

The mouth, nose, and pharynx should be inspected for foreign bodies. As it may be sometimes necessary to establish the identity of the corpse, the existence of any peculiarities or malformations should be noticed, also the condition of the skin, more especially as to the presence or absence of the vernix caseosa, for if this be absent, we may infer that the child has been washed, although not necessarily born alive. The condition of the cord should be noted, whether succulent or mummified, also the state of the umbilicus with reference to the healing process. Evidences of an inflammatory process in this locality show that the child has lived some time after birth. Fractures of the long bones cannot of themselves be considered evidence of criminal violence, as they not infrequently occur as the result of accident in ordinary labors. If the body of the child be found wrapped in a covering of any kind, this should be carefully preserved, as its subsequent inspection may furnish a valuable clue to the identity of the child. Perhaps the most important point connected with the technique of the internal examination of the body is the rule which requires that the abdomen should be opened before the thorax. This is for the purpose of ascertaining the position of the diaphragm with reference to the occurrence of respiration, in which case the convexity of the diaphragm is said to be found at from the fourth to the seventh rib, but if respiration has not taken place it reaches only to the fourth or fifth. Evidently if the position of the diaphragm were the only evidence available in deciding so important a point, in those cases where the diaphragm is found at the fourth or fifth rib, as far as this point is concerned, the child may or may not have breathed, and can only be of value where the diaphragm is found occupying the lowest of the positions possible. In any event, this can be only of value as corroborative evidence.

The technical part of the autopsy is conducted precisely as in the adult. The scalp is reflected in the same manner, when the calvarium may be removed with a pair of stout scissors. It is not uncommon in cases of difficult or instrumental labor to find extravasations of blood, not only on the surface of the dura, but also in the subdural space, and even in the substance of the brain itself, although some writers consider that effusions in the substance of the brain are sure signs of extreme violence. These may exist either as simple ecchymoses or as genuine clots. On this account the medical examiner should be extremely cautious in making the deduction that such appearances are the result of criminal violence. It may be remarked, however, that the more difficult a labor the more difficult will concealment have been; and if instrumental interference has been necessary and concealment practiced, the probable collusion of a practitioner must be inferred.

The brain presents no peculiarity worthy of mention. It is somewhat softer than in the adult, and a little pinker. The thorax is opened as before directed, in the adult. The principal point of difference to be noted here between the infant and adult is the presence of the thymus gland, which in the infant covers the lower part of the trachea and the great vessels. It is about two inches in length, about one inch in breadth, and a quarter of an inch in thickness. It is a light fawn color, and extends upward as far as the thyroid body and downward as far as the cartilages of the fourth rib. The thyroid and thymus glands are connected by two flattened bands of fibrous tissue, which are prolongations of the capsule of the thymus. The weight of this structure at birth is about half an ounce. Immediately on opening the chest, the position of the lungs in the pleural cavities is to be noted, and also their relation to the pericardium. When the child has not breathed they lie shrunken in the posterior part of the chest, whereas when the child has fully respired they fill up the chest and cover the pericardium. They are then, moreover, of a light pink color. It must not be forgotten that if the observation regarding color be deferred until the lungs have been exposed some time, they may acquire a light color from imbibition of oxygen. Previous to the removal of the thoracic viscera, a ligature is to be placed on the trachea and great vessels. After removal the lungs must be weighed separate from the heart in order to obtain the data for the static test, which depends on the fact that the lungs are heavier after respiration has been established than before. As the weight of the lungs must vary with the weight of the child, the data which are often given for purposes of comparison cannot be considered very reliable. Petechial spots are often seen on the surface of the pleura in cases of death from suffocation, but as they may occur in death from other causes, they must be noted with due allowance. As usually directed, the ductus arteriosus, the ductus venosus, and the foramen ovale are to be inspected with reference to patency or closure. They may not be completely closed until a week after birth. The amount of blood contained in the cavities of the heart is to be measured or weighed. The same appearances are to be expected in the internal viscera in death from apnœa occurring in infants as in adults.

The abdomen, previously opened for the determination of the position of the diaphragm, may now be dissected. The stomach and intestines are to be examined with reference to the presence of air, food, and

blood. It has been shown by Breslau that there is no air in the stomach or intestines of new-born children. The stomach and small intestines, if there is suspicion of poisoning, should be removed in the same manner as in the adult. In any case, the contents, if any, should be tested for the presence of starch, and examined microscopically for the oil-globules of milk. Blood may sometimes be found in the stomach. Its presence has not the same significance as that of milk or starch. The liver in the infant is of large size in proportion to the body. It is said to diminish in size after the establishment of respiration, but this fact is of little significance. Large extravasations of blood are sometimes found under the capsule of the liver, without known cause. (Delafield.) The spleen may be abnormal in size. The kidneys are lobulated. The bladder may be full or empty. It is rare that the spinal cord needs examination. If, however, the examiner deems this necessary, the same precautions are to be observed against the production of artefacts as in the case of an adult. The natural and great mobility of the head on the spinal column in the infant should not be forgotten.

In conducting the examination of bodies advanced in putrefaction, we are compelled to modify, not so much our methods, as the conclusions which we are enabled to draw from the autopsy. The identification of the body in these cases is always important and often difficult. After the features have become undistinguishable the question of sex can always be determined, even when a further identification is impossible. Long after the external parts of generation have become undistinguishable the sex may be determined from the presence of hair on the face or the length of the hair of the scalp. The circle of hair which surrounds the pubes is characteristic of the female, while its prolongation upward in the median line is equally distinctive of the male. In the bodies of children too young for these peculiarities to be available, even although the soft parts have become an undistinguishable mass, the uterus may still be recognized. In the adult it is possible thus to determine the existence or non-existence of pregnancy months after burial. The uterus is not only last in the order of putrefaction, but is still distinguishable long after all the other soft parts have become an undistinguishable mass. Casper gives numerous instances of this fact. In one case, that of a young servant-girl drowned in a privy and discovered nine months subsequent, although all the other soft parts had either been changed into adipocere or were but black and greasy masses, from out this mass of putridity Casper was able to separate the uterus, which was of a bright red color, firm, hard to feel and cut, its form perfectly recognizable, its size that of a virgin uterus, its cavity empty. As it had been charged that the girl was pregnant by her master at the time of her death, Casper was thus enabled to prove that this accusation was unfounded, in spite of the fact that the body had lain in a privy for nine months.

Such a case as this ought to teach us that there is no stage of decomposition in which we may not expect to gain useful information from an autopsy. Frequently the question of sex is the only fact relating to identity that the examination will settle. Here, however, it is sometimes possible to gain additional information from such peculiarities as old or recent fractures, and peculiarities of the teeth. In case a recent fracture is discovered there is a question which may arise, not necessarily connected with that of identity, as to whether the fracture was the result

of violence inflicted before or after death, also its relation, if any, to the death of the person injured. If the fracture be of the skull, an examination of its interior may reveal the presence of extravasated blood or of an inflammatory process, as evidenced by the presence of pus, in which case the answer will not be difficult; but if the progress of decay is too far advanced to admit of this, it will be extremely hazardous to attempt to give a definite reply. If callus be found, it is quite certain that the fracture preceded death at least a week, or, according to the amount and condition of the callus, even longer. Fractures of the base of the skull are not likely to be produced after death, and if extensive fractures of the vault are present, it is most unlikely that they have been produced other than by violence before death. Circumstances may cause us to modify such a declaration as this—as, for instance, where a body is found in the ruins of a fire with the skull crushed and other bones fractured. Here the character of the fracture in the skull will determine whether it was the result of injuries inflicted beforehand, as the sharp incised fracture produced by a cutting instrument, as an ax, can readily be distinguished from the crushed condition resulting from the impact of a mass of debris. The findings which it is possible to make from the soft parts of a body much decomposed, particularly as to the existence of disease, will largely depend on the degree of disorganization of the organs which the inquiry concerns.

Every anatomist is familiar with the rapidity with which the tissue of the brain undergoes putrefactive changes. Therefore, while it may still be possible to harden and make sections of the brain quite late, yet it would be dangerous to draw any conclusions, with regard to pathological processes, based on a microscopic examination of such sections. If it is possible to produce artefacts in the comparatively firm texture of the cord simply by rough handling, how much easier may this happen as the result of the softening produced in a texture so little refractory as that of the brain. After putrefaction has advanced to any extent in the external tissues, we are only justified in making such findings as are based on the grosser lesions—as, for instance, the presence of decomposed blood-clot or the existence of pus. The same remarks apply to the microscopic examination of other structures, as the kidneys and liver, in proportion to their power of resisting putrefactive processes. He is certainly a bold, if not a reckless, pathologist who is willing to make statements based on a microscopical examination of these organs many days after death, unmindful of the cloudy swelling and other progressive changes which so quickly occur in their epithelium. It is quite possible, however, to determine such microscopic changes as an altered relation in the cortical and medullary portions of the kidney, the contracted liver of cirrhosis, or an undue predominance of connective tissue. These facts are, of course, evidence of chronic disease rather than the acute processes so often sought for. Acute changes in the digestive tract, owing to the fact that the stomach and intestines decay relatively early, cannot be discovered with certainty long after death, as the stomach commences to putrefy in about six days thereafter; and the changes in coloration are thenceforward so various, its condition in other respects so changeable, that it is difficult to give a precise opinion with regard to its possible condition in life.

With regard to the detection of metallic poisons, it may be stated

that no degree of decomposition is incompatible with their discovery by appropriate analysis; therefore the stomach and intestines should be removed as carefully as possible, taking the same precautions as directed heretofore. It is usual in such cases, whether the body has been buried or lain exposed, to remove a portion of the adjacent soil in order to exclude by analysis the presence of a metallic poison therein. This precaution should not be neglected. The foregoing remarks apply equally to autopsies performed on bodies advanced in putrefaction, whether before burial or after exhumation. Such autopsies are not attended with unusual risk to the examiner. Post-mortems in fresh subjects are attended with far more risk. Indeed, the only serious consequences which the writer ever saw occurred in recent cases. In an experience of over five years in the dissecting-room of the Long Island College, no cases of poisoned wounds ever came under the author's observation, although he saw many cut fingers and one or two bad lacerated wounds made with the saw in process of removing the calvarium. Late autopsies should always be made in a room through which a draught of air is blowing, and such precautions taken as will readily occur to the reader. Exhumations should be made with care, rather, however, with reference to the dead than to the living. When bodies are buried in the cheap pine coffins of the poorhouse, the thin shell soon decays, and cannot be used to raise the body from the grave. In this instance, a sheet of stout canvas with rope handles on either side may be slipped under the frail coffin, which may then be removed from the grave without accident.

It occasionally happens that the medical examiner is required to make medico-legal inspection so long after death that the bones alone are left. When it becomes necessary to disinter the remnants of the body in such a case, it is best to take the following precautions, in order that all the bones may be recovered: a space much exceeding that of the grave is to be dug over, and the earth in the vicinity of the remains carefully sifted through a moderately fine sieve. In this way the small bones of the carpus and tarsus may all be recovered, and such fragments as the separated bones of the infantile skull. There is one case on record where the identification of the body depended on the fact that the fifth metacarpal bone of the right hand possessed two articular facets, the deceased having had a supernumerary finger to which the second facet corresponded. (Reese.) It would have been impossible in this case to have identified the exhumed bones had it not been for the discovery of so small a bone as the fifth metacarpal.

The main facts to be determined by the inspection of bones are: first, the identity of the remains; second, whether they throw any light on the cause of death. It is evident that the question of identity must depend on the determination of sex, age, and stature. It is easier to speak precisely with regard to the first two points than the last. In mature bones, it will never be difficult to distinguish the peculiarities of the two sexes, where the pelvic bones are entire. In the male, the obturator foramen is oval rather than triangular, as in the female. With regard to the pelvis as a whole, it is to be noted that the bones are more massive and the muscular impressions more prominent in the male than in the female. The subpubic arch is narrow and angular in the male, much wider and more arched in the female, the respective angles being seventy-five and a hundred degrees. The actual size of the pelvis varies in different individ-

nals; in the male, however, the antero-posterior diameter is the greatest, whereas in the female the bilateral is the largest. The bones in general of the female are more slender proportionately than those of the male, and if the age of the remains can be fixed, even though the pelvic bones are missing, by comparing the proportion of the bones with their estimated age it may be possible to form a fairly positive opinion as to the sex of the remains. No positive opinion, however, ever ought to be given which is not based on an inspection of the pelvic bones. When the teeth are present, up to the age of twenty-one the age of the skeleton may be determined by them alone. If no teeth be found, the age of the bones must be determined by the degree of ossification of the various bones, and by the union of the epiphyses to the shaft of the long bones. This is of no avail after the age of twenty-four, at which time the upper epiphysis of the tibia unites to the shaft of the bone, being the latest of all the epiphyses to unite with its shaft. From the twenty-fourth year until middle life it is not possible to form any exact idea of the age, as ossification is complete. If the metasternum is found joined to the mesosternum by bone, it may be concluded that the individual had reached middle life. It is quite exceptional for the presternum and mesosternum to be united by bone, but when this is found it is probable that the individual had attained the age of sixty. The same applies to the bony union of coccyx and sacrum. The process of absorption which takes place in the alveolus of the lower jaw, and the approach of the mental foramen to the lower border of the bone, are also signs of old age. After the age of twenty-four it is only possible, therefore, to say that the individual was middle-aged, or that he had reached the age of sixty, or that he was an aged man.

Not infrequently the teeth are found detached from the jaw-bone. The following brief description of their points of difference may serve to then distinguish them. The central upper incisors are very much larger than the laterals; the lower central incisors much narrower than the upper set. The root of the first bicuspid is either single or marked by a single longitudinal depression, while the root of the second is double. The lower bicuspids are smaller than the upper, and have single roots. The upper molars have four cusps and three roots; the first of the lower molars has five cusps and two roots, which are sometimes completely divided by a groove so as to make four; sometimes only one root is so divided in this way. The second lower molar has but four cusps or a faintly developed fifth cusp. Its roots have a tendency to coalesce. The roots of the upper wisdom tooth coalesce and form a cone. The lower wisdom tooth has two roots, which may become confluent. (Morris.) When no teeth are found, but only a few of the larger bones, we must rely on the degree of ossification of the bones and the condition of the epiphyses.

DEATH IN ITS MEDICO-LEGAL ASPECTS.

BY

FRANCIS A. HARRIS, M.D.

In the preparation of an article which shall treat of the subject of death in its relation to forensic inquiry, with the consideration of the phenomena attending and following upon certain forms of violent death, it must be obvious that little that is absolutely novel can be offered to the student of legal medicine who has availed himself of the careful and scientific exploitation of the subject by such eminent writers as Devergie, Tardieu, Casper, Taylor, and Ogston, who from their great opportunities for observation, and from the fact that most of them occupied positions under governments which at a very early period recognized the importance of this branch of medical investigation, and which provided a certain fixed and logical method of inquiry, have been enabled to present most accurate data in the matter of medico-legal examinations; and the writer acknowledges at the outset that he has availed himself, in the preparation of this article, of the results of their labors as found in their published works. He will only endeavor to present such facts as have already been found to obtain, and, if possible, to emphasize them by such illustrative cases as have come under his personal observation in the course of the past sixteen years, while acting under the provisions of the so-called medical-examiner law of Massachusetts.

Governmental Regulation.—Other countries, notably France and Germany, have for a long time had statutes which provided for the action of medical experts in criminal cases, or in those which were supposed to be such, and have even laid down with the greatest care and minuteness not only the legal steps to be pursued, but definite instructions as to the method of performing an autopsy and recording the results of the same.

The United States has not thus far advanced. In most States the old-fashioned, illogical, and practically worthless system of investigation, derived from the English custom, the coroner's inquest, still is the primary court of inquiry, and the solutions of questions of great moment to the State and the individual are still left to men who have neither the legal nor the medical training requisite to determine either the cause of the death in a given case or decide the responsibility, if there should be any.

The Massachusetts law still leaves much to be desired both in the matter of accurate phrasing and the complete instruction as to details of a medico-legal examination. It is, however, a great step in advance of anything which has obtained before, and has worked very well in practice. The essential points of the law are that in the first place it follows

a logical order, and when there is to be an investigation into the manner of any suspicious death it puts the primary part of the inquiry—namely, Was this death one that resulted from violence, or did it result from natural causes?—into the hands of trained medical men, who under certain conditions and under certain proper restrictions make the autopsy; and it puts the second part of the inquiry—if there should be demonstrated the fact that the death was due to violence rather than to natural causes—into the hands of a judge of a court of first instance, who reports his finding to the superior court, and so everything is in train for prosecution. At the outset there was naturally doubt in the minds of the medical men acting under its provisions as to what really was meant by a dead body. They were required to act if they received notice that a dead body was lying within their district; but the courts had never decided what a dead body was. Was it a fœtus in the very early stages of development? Was it a child that was at viable term, say at the period from one hundred and eighty to two hundred and ten days, or must it be a child at term to be considered a body within the meaning of the law?

Accepted Period of Life.—Medically, a fœtus at the fourth or fifth month, although incapable of independent life, is a human being; but up to 1893 there had been no decision as to its status in law, that is, by the Massachusetts courts. The laws of foreign countries had made the distinction that a child must be wholly born alive before it could be the subject of an assault, and had even gone further, and decided that a child who was born alive and had lived not only for hours, but even days, but who on account of some congenital deformity, such as atresia of the rectum or the œsophagus, was incapable of sustaining independent life, is not a human being within the meaning of the law, whether civil or criminal. On the other hand, a child who had been born alive at a time when it was capable of sustaining a life independent of the mother, even if it was born prematurely, would be a subject of criminal assault like any other human being. During the present year, in the course of a trial for infanticide it was found that there had been no decision on this point in the State of Massachusetts, and for the first time the law was made, following the English law, that it must be proved that the child had been wholly born alive and capable of maintaining a separate existence before a charge of infanticide could be sustained.

Whether this law has been established by the courts of other States or not, the writer has no knowledge; but it is probable that if it is to be established it will be on the same lines. Such legal requirement, of course, increases the difficulty of securing the conviction of persons charged with killing a new-born child; but that is a matter which more nearly concerns the bar and the judiciary than the medical jurist.

The medical jurist may be required to examine the body of a fœtus at any term when the question of pregnancy is involved; but in general, he has to consider that only as a dead body which has arrived at least at a period of development where it is capable of sustaining independent life—that is, from the one hundred and eightieth to the two hundred and tenth day, and later.

The Determination of Death.—At the above-named period and later, a dead body, as far as the purposes of forensic inquiry are concerned, is a dead human being, and an investigation into the cause of its death

may be necessary to assist the criminal courts; and, furthermore, an examination of a dead body may be necessary to establish certain civil rights, such as succession, by determining the period at which death has occurred.

This brings us naturally to the consideration of the signs of death, and the changes produced in the economy by the cessation of the vital functions.

Identity of the Dead Body.—Before proceeding directly to that subject, however, it occurs to me that a few words on the question of establishing the identity of an unknown body may not be out of place, as such an inquiry would naturally precede the autopsy itself. I am indebted to Dr. C. A. Hebbert for very great assistance in the preparation of the portion of this article relating to this question of identity. His experience with Mr. Bond, of London, renders his work of great value, and several cases cited by him in the Westminster Hospital reports are exceedingly interesting.

The determination of the identity of human remains is one of the most important and often most difficult problems submitted to the medical jurist. It is especially interesting to the student of forensic medicine in the United States, as the nation is composed of people from all parts of the world. Not only are met members of all the European races, but also the negroid, Australoid, and Mongoloid races, each presenting different and distinct characteristics. The examination will also include the subordinate or mixed people, such as the mulatto, a mixture of the European with the negro, the mestizos, a mixture of the European and the American indigenes, and the zambos, a mixture of the American indigenes with the negroes, and in these sub-races the physical characters and proportions are necessarily modified. These sub-races are particularized, inasmuch as they are all prolific and not sterile, as is the marriage of the European with the Australoid.

Let us first consider the cases where the whole body or the whole skeleton has been found, and secondly where the body has been mutilated, dismembered, or partially destroyed, so that only a portion or portions have been discovered, and see how far, from such data as we have, we can identify the individual.

Such study will involve observation of the following points:

1. Race.
2. Sex.
3. Age.
4. Stature (including measurement of body and limbs).
5. Features (hair, nails, etc.).
6. Scars, moles, depressions on fingers by rings, or on legs by garters.
7. Deformities.
8. Occupation, as shown by stains on body or fingers, or tanning by exposure to the sun, callosities (bursæ, corns, etc.), the effects of pressure of dress on various parts of the body, the presence of foreign substances on the body (hair, straw, flour, etc.).

In addition to the above there is to be remembered the great value of photography, not alone in the case of the features, but also where several portions of a corpse are found at different intervals, and the question arises whether they belong to the same individual. In such a case, in addition to detailed measurements, photographs of the two arms

or of the two feet would be of material assistance in determining the question of identity.

1. **Race.**—Where the corpse is entire and but partially decomposed, no great difficulty will be met, as the characters of the four great families are distinct; but it will be useful to bear in mind a brief summary of these features.

(*a*) *The Australoid type*, such as the coolies in southern India and the native Australians: skin chocolate-colored, hair black and wavy, the skull narrow or dolichocephalic, the brow ridges prominent, with a projecting or prognathous jaw, and thick lips; the nasal index platyrhine.

(*b*) *The negroid type:* the skin dark brown to black, the hair black, crisp, or woolly, the skull dolichocephalic, the brow ridges not prominent, the jaw prognathous, with fleshy, protuberant lips, the nose and nasal bones flat, the index being platyrhine.

(*c*) *The Mongolian type*, which includes the Chinese, the Japanese, and the American indigenes: skin from yellowish brown to a mahogany tint, the skull broad or brachycephalic, the hair black and straight, the brow ridges not prominent, the jaw not projecting except in the Esquimaux, the nose mesorhine, small and flat in the Japanese and Chinese, with oblique eyes, and the cheek-bones high. In some of the American Indians the nose is prominent; but as we are dealing with such peoples as are commonly met with, it is not necessary to do more than specify the typical features of the main group.

(*d*) *The whites*, divided by Huxley into the Xanthochroi, or fair whites, with pale skin, fair, wavy, or curly hair, light-colored eyes, mesocephalic skull, jaw orthognathous, and nose leptorhine; and the Melanochroi, or dark whites, the complexion darkening to a sallow or swarthy hue, the hair dark, and the eyes brown or black, the skull mesocephalic, with orthognathous jaw and leptorhine nose.

The comparison of the foregoing characteristics will at once decide the question of the membership of a definite race; but as in the sub-races the skull and facial points are modified by the mingling of types so that other and probably external circumstances will be required for a proper decision, these will be considered hereafter, chiefly under the discussion of features. (*Vide* Identity of the Living.)

No mention is made of the stature or size of races, as it is well known that the height of individual members of each race varies, the Melanochroi, for instance, though being smaller than the Xanthochroi as a rule, having among them large and powerful individuals, and in the negroid group the Bosjesman is much smaller than the average negro. The value of the various indices, cephalic, facial, and nasal, is as follows. The cephalic index is the comparison of the length of the skull to its breadth, the length being taken as 100. The length of the skull is taken from the ophryon to the occipital point, the breadth the greatest interparietal measurement. If the index is above 80 the skull is brachycephalic, as in the Mongoloid races; if from 75 to 80, mesocephalic, as in the whites; if below 75, dolichocephalic, as in the negroid and the Australoid races. For example, if the length is seven inches and the breadth five inches, the index is 71.4, or dolichocephalic. If the length is seven inches and the breadth six inches, the index is 85.7, or brachycephalic.

The gnathic index is reckoned by comparing the basi-alveolar length with the basi-nasal length, the basi-alveolar length being taken from the

basion to the alveolar point, the basi-nasal from the basion to the nasion, the basi-nasal being taken at 100. Below 98 the jaw is orthognathous; from 98 to 103, mesognathous; above 103, prognathous, as in the negroid or Australoid groups.

The nasal index is the comparison of the height of the aperture with the width, the height being from the nasion to the sub-nasal point, the width being the greatest transverse diameter of the anterior aperture, the height being taken as 100. If below 48, leptorhine; from 48 to 53, mesorhine; above 53, platyrhine, as in the negroid.

These indices are here exploited to furnish aid to such as may be obliged to examine a case where the head or skull alone is presented for investigation, and where the first step toward determining identity is the fixing the race, though such minute descriptions and measurements are rarely necessary. Still, the medical jurist should observe everything when he is examining a dead body, and this applies to the part as well as the whole, and in any medico-legal inquiry it is not always possible at the outset to say what may be of the most vital importance in the case before its conclusion.

The method of arriving at the above-mentioned indices may be made more plain, possibly, by the example of an equation such as the following:

Dolichocephalic, $7 : 5 :: 100 : x;$
$x = 71.4.$

Brachycephalic, $7 : 6 :: 100 : x;$
$x = 85.7.$

Figs. 4 and 5 are intended to illustrate the above-mentioned measurements.

2. Sex.—*The distinction of sex* where a whole unmutilated corpse is presented for inspection is too obvious to require comment. On the other hand, if the body is mutilated and decomposed, great care is required on the part of the expert, and still further difficulties are presented when it is the skeleton alone with which he has to deal. Indeed, there may be cases where the whole body has been so mutilated that it is by the preparation of the skeleton alone that an idea of the sex may be formed. Just such a case might have occurred in one of the so-called Whitechapel murders in London, in the years 1887–89. Here nine women were murdered and mutilated by an unknown assassin.

In the particular illustrative instance, the woman was murdered in a bedroom. The body was naked when found. The eyebrows, eyelids, ears, nose, lips, and chin had been cut off, and the face gashed by numerous knife-cuts. The breasts had been cut off, and the whole abdominal parietes, together with the external organs of generation, had been removed. The skin and much of the muscular tissue, not, however, exposing the bone, had been slashed away from the anterior aspect of the thighs as far as the knees. The abdominal viscera and pelvic viscera, including bladder, vagina, and uterus with appendages, had been torn from their cavities, and in fact there was no sign of sex except the long hair upon the head, and, as is well known, that alone is not a posi-

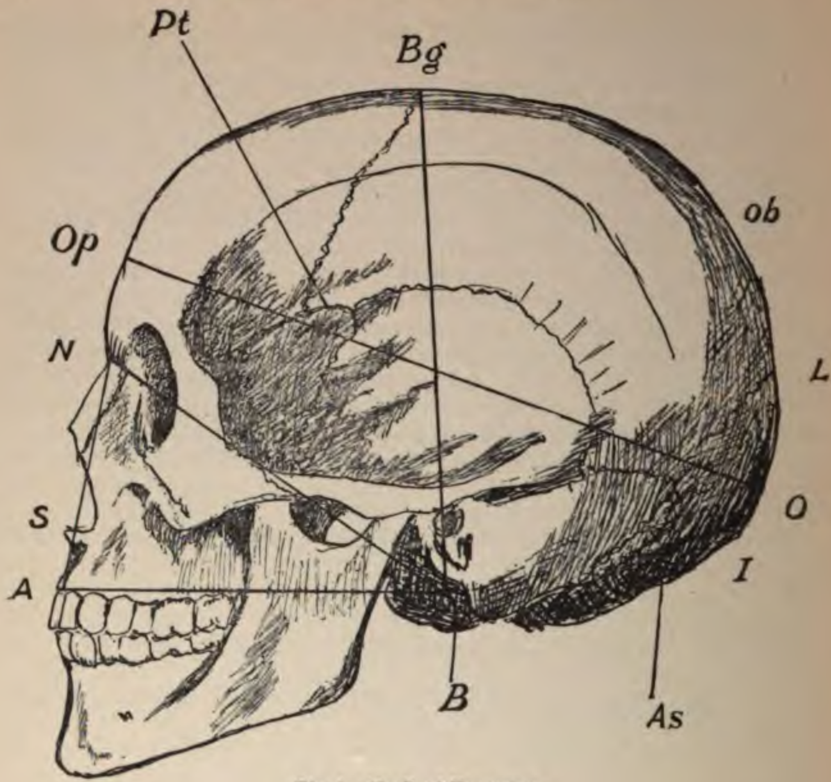

Fig. 4. Skull of European.

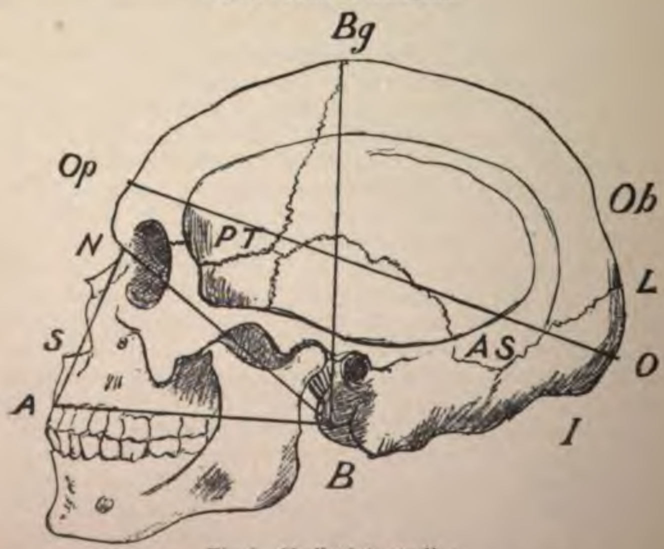

Fig. 5. Skull of Australian.

Op, ophryon; *O*, occipital point; *Ob*, obelion; *Bg*, bregma; *B*, basion; *N*, nasion; *A*, alveolar point; *S*, subnasal spine; *Pt*, pterion; *As*, asterion; *I*, inion, or external occipital protuberance; *L*, lambda.

tive sign, inasmuch as in some nations the hair is worn long by men. The fact that the whole bladder had been removed did away with the help that might have been afforded by the presence of the prostate gland. In this case, to be sure, all the organs except the heart were found scattered about the room, and showed the sex without doubt. But if all the organs and parts had been taken away or the body exposed to the effects of decomposition, a careful preparation of the skeleton would have been imperative to decide that the body was that of a woman.

It might further be stated that in this case, in consequence of the hacking of the features, the presence or absence of a beard could not be stated, and if the hair had been designedly cut off there would have been absolutely no sign by which sex could have been determined. The hair on the pubes had been removed in this case, and the difference in the growth of the pubic hair tapering up toward the umbilicus in the male, and simply surrounding the organs of generation in the female, could not be availed of as an indication of sex.

Of course, if there be only decomposition or destruction of the external organs of generation, the internal examination would decide the point of sex by demonstrating the presence of either a uterus or a prostate gland, both of which organs resist decomposition longer than most if not any other parts. In general, it may be said that the female is smaller, lighter, and has a less developed muscular system than the male; but here we are again met with the objection that a healthy, hard-working woman would have stronger limbs and more powerful frame than a sickly student or clerk.

Therefore, in the case of the examination being limited to a single limb, as an arm or a leg, it is in a measure guesswork, though with care the guess may be pretty accurate. A case in point will be cited *in extenso* hereafter, where an arm, large and muscular and lengthy, was decided to be that of a woman, and the opinion was at a later date found to have been correct.

The skeleton of the male is generally larger, stronger, and has more prominent processes and impressions for muscular attachment on the bones of the limbs than the female skeleton. The sternum is less convex, and the xiphisternal articulation is opposite the curve of the fifth rib, while in the female the sternum is more convex and shorter, and the xiphisternal articulation is opposite the curve of the fourth rib. It is in the pelvis, however, that we find the main distinguishing points. The male pelvis is composed of more massive bones, with rough, well-marked processes; the cavity of the true pelvis is deeper, narrower, and has smaller apertures. The curve of the sacrum is more evenly distributed, and not

Fig. 6. Pelvis of Man.

so abruptly marked in the lower part as in the female. The subpubic arch is more pointed, the obturator foramen oval, the tuberosities of the ischia nearer together, and the diameters of the true pelvis narrower than in the female, as will be shown in a subsequent table.

Fig. 7. Pelvis of Woman.

The female skeleton has a shallower false pelvis, with more widely spreading alæ ilii. The bones of the true pelvis are lighter, with much less marked impressions. The cavity is shallower, and the sacrum is flatter in the upper two thirds, and then curves somewhat abruptly below. The apertures are wider, the subpubic angle has a lower and rounder arch, and the obturator foramina are triangular, the rami of the pubes and ischium are more everted, and the diameters are much longer.

The following table gives the respective measurements as found in the male and female:

	MALE.	FEMALE.
	In.	In.
Distance between widest part of iliac crests	10–11	10½–11
Distance between antero-superior spines of ilia	9½–10	10–10½
Distance between front of symphysis pubis and sacral spines (external conjugate)	6½–7	6½–7½

True Pelvis Diameters.	MALE.			FEMALE.		
	Brim.	Cavity.	Outlet.	Brim.	Cavity.	Outlet.
	In.	In.	In.	In.	In.	In.
Transverse	4½	4½	3½	5½	5	4¾
Oblique	4¼	4½	4	5	5¼	4¾
Antero-posterior, or conjugate	4	4½	3¼	4½	5¼	5

In addition to the measurements of the pelvis it is also well to notice that the angle of the neck of the femur with its shaft more nearly approaches a right angle in the female than in the male; but this difference is only of importance where the limbs of the same or of different bodies can be compared, and is not a valuable sign where only one leg is discovered. The above indications should ordinarily be sufficient to guide the examiner to a proper decision in the matter of sex where this is in dispute, or the object of inquiry.

3. **Age.**—Though the features of the living are fairly well marked on external examination in each of the ages of man, from the infant to the "lean and slippered pantaloon," yet after death the effacing work of decay so rapidly alters the special characters that we require more decisive and scientific points to ascertain the probable age of the deceased.

Take the face as an illustration. The general suggestions of age from the wrinkles about the corners of the eyes, the so-called crow's-feet, and the deepening of the lines at the wings of the nose and corners of the mouth, the drooping of the angles of the jaw with the gradual approximation of the lips caused by the absorption of the alveolar borders of the maxilla, are all absent or modified in the first appearances after death; nor would the smooth, rounded look of the young give more than an indication of age, though an estimate with some degree of accuracy could be made by a trained observer. Therefore it is clear that more than a mere inspection of the external appearances is necessary. Take the case of a *newly born infant*, for instance, though this belongs more properly to a chapter on infanticide. We know that the length should be, for a child at term, eighteen to twenty inches, and the weight from six to eight pounds avoirdupois. The finger-nails project beyond the ends of the fingers, and the toe-nails reach nearly to the ends of the toes. The umbilicus is at most three quarters of an inch below the center of the length of the body. In the male the testicles are in the scrotum, and if the child has lived a short time the anus will probably be smeared with meconium. The most reliable sign of age at this period is the presence of a small ossific center in the lower epiphysis of the femur. It is the first and as a rule the only epiphysial center to appear before birth, though the upper epiphysis of the tibia can be occasionally noticed at full term. The femoral epiphysis usually appears shortly before birth. The size of this center is about one eighth of an inch in diameter. As the appearances of the epiphyses and their union with the bodies of the bones are the most important proofs of age from birth to the age of twenty-five, the different dates of their appearance must be borne in mind. To generalize these points is a matter of some difficulty; but it may be stated that there are times in the development of the body when growth appears to be more energetic. For instance, in the first three years there is ossific deposit in the epiphyses of the humerus, femur, ulna, tibia, and fibula—that is, the extremities are practically mapped out in bone; and it is also in this period that the fontanelles of the skull close and the cranial bones unite.

Fig. 8. Inferior Maxilla of New-born, showing Union of Rudimentary Processes.

Again, about *puberty* we have another period of activity, the vertebræ attaining their full size and shape, and in the pelvis additional centers appear in the sacrum and ossa innominata, so that during this time the trunk is solidifying. The *third period* of importance is that from *twenty to twenty-five*, the latter being the full attainment of adult age, and at this time in the majority of cases all the epiphyses have become joined to the bodies of the bones, though the complete ossification of the vertebræ may be delayed for a year or more.

After the age of twenty-five until the changes of advanced life, which will be hereafter alluded to, occur, it is difficult to satisfactorily determine the age from the points of ossification alone; but it should be remembered

that the sexual powers are in full activity, and in the female the breasts, the uterus, and ovaries will aid in determining the age. If there are signs of present or recent menstruation, the presence of corpora lutea either of menstruation or pregnancy, or the secretion of milk in the breasts, we should have an indication that the woman was probably under *forty or forty-five*. On the other hand, the presence of spermatozoa in the vesiculæ seminales or the testicles would not afford much assistance, as men have been known to have been capable of procreation at an advanced period of life. The eruption of the milk and permanent teeth affords a very trustworthy sign of the age of the young, and a case occurring in London is worth citing on that point. During the repair of a house, a few remains were found buried under the hearthstone, and these on examination proved to be those of a human lower jaw, with the small though well-marked mental process (no other animal has a chin), part of the upper jaw and shaft of a small femur, with some few light brown long human hairs. As the second molar teeth had erupted, and there was an indication of a cavity in the upper jaw where the first molar of permanent teeth had begun to develop, the age was determined as between three and four years. The hair indicated the complexion, and the length thereof the sex. On inquiry it was learned that a long time ago a little girl of three and a half years had disappeared. The mother of this child was confronted, and confessed that the girl had died of natural causes, and had been buried in this spot by the parents to escape the expense of an ordinary sepulture.

As age advances, structural changes occur in the cartilages of the larynx and ribs, so that they become ossified; but these changes may occur at any period after thirty, and indeed, are so modified by disease, such as that of the heart or kidney, that they are only a general indication. In old age, or in those who have lost their teeth, the alveolar borders of the jaws are gradually absorbed, giving the angle of the jaw an appearance of obtuseness which is more apparent than real. The angle of the neck of the femur with its shaft is obtuse in man, rectangular in woman, and with increasing age the angle becomes more rectangular—may even sink below the level of the trochanter.

From the foregoing it will be seen that our best guide to the ascertainment of age is the examination of the skeleton; but that even that is not wholly accurate, but only approximate, and that all other appearances possible must be considered in arriving at a correct solution of the problem.

The following résumé, chiefly from Quain, will be of service in determining identity as far as light is thrown on the matter by the study of the matter of ossification. The value of this test of age will be found principally in the examination of the long bones and the pelvis; and while in works on forensic medicine it is customary to give very elaborate tables of all the times of appearance of centers and junction of epiphyses with the bodies, in practice it is better to consider these special parts in the three periods before mentioned.

In the first year the nucleus for the head of the femur appears.

In the second year nuclei for the head of the humerus, lower extremities of the tibia and fibula, carpal end of radius.

In the third year the nuclei for the great tuberosity of the humerus, upper end of the fibula, capitellum of the humerus.

In the fourth year the nuclei for the great trochanter of femur, and carpal end of ulna.

In the fifth year the nucleus for the lesser tuberosity of humerus, which, uniting with the greater tuberosity and head, forms a distinct epiphysis. In the same year appear the nuclei for the internal condyle of humerus and the head of the radius.

Thus in the first five years we have the most of the important epiphyses of the long bones; the lower end of the femur and the upper end of the tibia, as before mentioned, being in evidence at or soon after birth.

In the age period eleven to fourteen are to be found the nuclei of the trochlea and external condyle of the humerus, a small epiphysis of the olecranon and the lesser trochanter, and at the period of puberty the three portions of the innominate bone are united in one by the ossification of the Y-shaped epiphysis in the acetabulum.

It must be remembered that the blending of the epiphyses of the long bones takes place in an order the reverse of their appearance, with the single exception of the upper end of the fibula.

From sixteen to eighteen, union between the bones and the lower epiphysis of the humerus and the upper epiphyses of the radius and ulna occurs.

From the eighteenth to nineteenth year occurs the union of the head of the femur and the lower end of the tibia.

In the twentieth year union occurs in the head of humerus, lower end of radius and ulna, and lower end of femur.

In the twenty-first year this process occurs in the upper end of tibia, and of the epiphyses of the metacarpal and metatarsal bones.

In the twenty-fourth year the process occurs in the upper end of the fibula, and in the twenty-fifth in the sternal end of the clavicle, the acromial process of the scapula and crest of the ilium unite with their respective bones, the ossification of the vertebræ is completed, and at this, the period of adult life, the whole skeleton becomes ossified.

The eruption of the teeth is in the following order:

Milk Teeth.

Central incisors	Sixth month.
Lateral incisors	Sixth to ninth month.
First molars	Eighth to twelfth month.
Canine	Eighteenth month.
Second molars	Twenty-fourth month.

Permanent Teeth.

First molars	Sixth year.
Central incisors	Seventh year.
Lateral incisors	Eighth year.
First premolars	Ninth year.
Second premolars	Tenth year.
Canines	Eleventh to twelfth year.
Second molars	Twelfth to thirteenth year.
Third molars	Eighteenth to twenty-fifth year.

Of course, it must be borne in mind that the time of the eruption of the teeth varies, and especially in weakly, scrofulous, and rachitic children, where dentition is both irregular and delayed; but here only the

normal growth and development is taken as the standard both in regard to the teeth and the ossification of the skeleton.

At the end of the article on identity some illustrative cases will be cited, in which the determination of age was an interesting feature, and in one the exact age was decided by the fact that the acromial end of the scapula was not united, while the upper epiphysis of the fibula had evidently only recently joined the shaft.

4. **Stature.**—The estimation of stature is our next consideration. There are many inaccuracies and differences in each of the various modes of estimation usually adopted. If the whole skeleton be found, by placing the bones in position and adding one and a half inches for the soft parts, we shall get a fairly accurate notion of the stature, allowance being made for any shrinking of the bones or partial destruction of their ends. Next we will take the method of calculating the height by measuring the long bones, and according to Orfila's tables, as quoted below, the result differs to the extent of several inches. Roughly speaking, however, it may be said that the length of the femur equals one quarter of the whole length of the body.

In analyzing Orfila's tables we have separated the observations on the upper and lower extremities.

ORFILA'S TABLES.

Upper Extremity.						*Stature.*					
	Ft.	In.	L.			Ft.	In.	L.			
First Table.				Maximum.			Minimum.			Difference.	
Humerus, 6 observations..	1	1	0	6	1	3	5	9	9	3	6
Ulna, 7 observations		10	8	6	1	3	5	5	0	8	3
Second Table.											
Humerus, 19 observations.	1	2	6	5	8	1	5	4	6	3	7
Ulna, 14 observations.....		10	8	5	10	10	5	5	8	5	2
Lower Extremity.											
First Table.	Ft.	In.	L.	Maximum.			Minimum.			Difference.	
Femur, 7 observations...	1	6	1	6	0	0	5	7	0	5	0
Tibia, 7 " ...	1	3	0	5	10	6	5	5	0	5	6
Second Table.											
Femur, 12 observations...	1	5	9	5	9	8	5	4	6	5	2
Tibia, 11 " ...	1	2	5	5	9	8	5	4	6	5	2

The great discrepancy in the calculation will be seen from these tables; but to make such tables valuable, the age of the bodies examined, the entire absence of disease, such as bowing of the bones or curvature of the spine, ought to have been noticed, and the same difficulty constantly occurs in deciding the stature of the whole body.

Observations made by Dr. Hebbert, of London, in very many cases—upward of one hundred—in the post-mortem room on the full length of the femur, show that this bone equals in length one quarter of the full length of the body, the variation in general being about one inch.

The next method of estimation is by measuring the length, by taking the upper border of the symphysis pubis as the center of the body after

the twenty-fifth year. M. Sue first suggested this mode, but Orfila attempted to show that there was an average difference of two and one third inches, and that usually the lower half was the shorter, especially in women. As the top of the head of the femur is on the same line as the top of the symphysis pubis, it follows that the total length of the lower extremity is equal to one half the total length of the body.

M. Sue's tables take an average from numerous observations:

Body.	Trunk.	Lower Extr.	Upper Extr.
5 ft. 8 in. 2 l.	2 ft. 10 in. 1 l.	2 ft. 10 in. 1 l.	2 ft. 8 in. 0 l.

According to Orfila, in women six out of seven have the greatest length from vertex to pubes.

In men (fifteen observations), vertex to pubes, 2 ft. 9 in.; lower extremities, 2 ft. 7 in.

The commonest mode, however, and the one which has hitherto been most relied on, when only the arms or upper parts are found, is the *figure carré des ancients;* that is, when the body is lying flat with legs extended, and the arms lying at right angles to the trunk, a square can be described around the body. Now this, although fairly correct in the living subject, is faulty in three ways when applied to a single limb. We are told to double the length of the arm, and add twelve inches, five for each clavicle and two for the sternum. Now, the first error is that when the arm is at right angles to the trunk the head of the humerus is from a half to three quarters of an inch to the inner side of the acromial end of the clavicle. Secondly, the sternal ends of the clavicles projecting more forward than the outer ends, an obtuse-angled triangle is formed with the apex forward, and we ought to take the measure along a transverse vertical plane of the trunk, that is, the *base* of the triangle instead of the sides; this difference is from half an inch to one inch, as verified by several measurements of skeletons. Thirdly, in females the outer end of the clavicle is directed a little, though very slightly, downward, as shown by their more sloping shoulders, so that to calculate from the exact length of the clavicle would again give two sides of a triangle instead of the base. This mode of estimating height is furthermore misleading in females, on account of their relatively shorter legs, so that it cannot be safely trusted. Other methods are derived from the ancient Egyptian canon, viz., that the length of the middle finger, as measured down from the root of the thumb-nail at right angles to the axis of the middle finger when the hand is laid flat on a table, equals one nineteenth of the height, and that the forearm, from the tip of the olecranon to the end of the mid-finger, equals five nineteenths of the height.

In order to be accurate in these measurements, several observations should be made, forasmuch as, if only a finger be measured, an inaccuracy of one sixteenth of an inch will give a false result.

In a case to be afterward given in detail, it will be seen that the two measurements agreed to one fortieth of an inch.

A number of observations were made in London by each of these last methods, both in the living and the dead, and the conclusion derived is that they are both fairly reliable, and especially the calculation of the measurement of the forearm, which has been for centuries a standard of measure under the name of cubit. According to the old Egyptian canon,

the human body can be divided by transverse lines into nineteen parts, of which five parts represent the length of the forearm and hand, and one part the exact length of the middle finger. This measurement must be made not from the prominence of the knuckle, which is the head of the metacarpal bone, but from the upper end of the proximal phalanx, which is exactly on a line with the base of the thumb-nail in a well-proportioned man.

In the latter part of this section are indicated the methods of measuring the body. The points of measurement of the height and breadth, and the various indices of the skull, have been described under the heading of race. The circumference of the skull is taken in a plane from the ophryon in front to the occipital point behind.

If the limbs be still attached to the trunk, in measuring the two arms it is usual to measure from the tip of the acromion to the external condyle of the humerus, and thence to the styloid process of the radius, all these being in one straight line; and from the last point the length of the hand is to be measured. The legs are measured from the top of the great trochanter externally to the heel, and internally from the symphysis pubis to the heel. If separated from the trunk, of course the greatest length is selected. In measuring the circumference of the limbs, it is best to take the greatest measurement, and then take measurements at different points expressed in inches from a flexure of the limb or other fixed points. The umbilicus is always below the center of the line from the xiphisternal articulation to the pubes, and about a half-inch to one inch above the highest point of the iliac crest. The circumference of the trunk should be taken transversely at the nipple line—that is, opposite the fourth rib and just below the costal arch.

5. **Features.**—The general character of the capital features in the great races have already been indicated; but in addition the exact lineaments of the individual should be described, such as the size and color of the eyes, the shape of the nose, the curve of the lips, and the shape of the ear, mentioning whether it projects or not from the head, the presence or absence of the lobule, the character of the helix, and the presence of the Darwinian tubercle, a small projection just at the curve of the helix. The teeth should be carefully examined to note those absent, or to remark the presence of artificial teeth. Apropos of this examination of the teeth, it may be remembered that in a case in London known as the Great Coram Street murder, an apple with a single bite taken was found by the woman's bedside. A cast of this was taken, but it proved to correspond to the woman's own mouth.

This is an instance of the importance of never missing any detail, though in this case it did not lead to the discovery of the murderer. Apart from the general description of the indices of the head and face, any peculiarity of the skull, such as undue prominence of the frontal or parietal eminences, or of the supraorbital ridges, or the deep depression often found in front of the lambdoid suture, and which an ignorant person might take for an old depressed fracture, should be noticed. The chin and lower jaw, which are very significant features, should be examined.

The color and character of the hair, both in head and face, are the next points to be noticed. The difference between human and animal hairs will be discussed later. Care must be taken to discriminate between

general or partial baldness, whether due to personal peculiarity or to advancing life, and the alopecia of constitutional disease, such as syphilis or that due to fungi, e.g., alopecia decalvans. After the description of the features of the face and head, the body should be noticed in detail. In the female, the breast, the pelvis, whether large or small, the external organs of generation, including the orifice of the vagina, must be examined, and any peculiarity or malformation noted.

On the lower part and sides of the abdomen may possibly be seen the lineæ albæ, which have been caused by overstretching of the abdominal walls, and usually, though not necessarily, associated with pregnancy. In the male, after examining for any defect of the genitalia, the result of circumcision should be looked for, though, as said elsewhere, this is a practice not now confined to Jews and Mohammedans. In both sexes the inguinal glands should be examined.

In describing the arms first note the general appearance, the greater muscularity of the male, the deltoid, triceps, and biceps being specially prominent, the flatter forearm, and wider, thicker wrist of the man, while the woman's arm is rounder and softer, the wrist more slender, and her fingers more tapering.

Note also the nails, their shape and appearance, as to their having been pared or bitten or neglected. In the living the question may arise, as in the great Tichborne case, as to how far the features may be modified by age and by change of life and habits, the claimant being a very coarse, corpulent man with bloated features, and the heir who originally disappeared being a slim youth with delicate face and timid manner. Another feature in this remarkable trial was the peculiarity of the genital organs, an unusual condition being present in the claimant, and known to be a peculiarity of the missing heir. In this trial it was stated that the direction of the curve of the two eyes was markedly different, and also the shape of the nose and the condition of the ear, the claimant having ears with large pendulous lobes, and the real heir small ears without lobes.

6. Scars, etc.—A scar or cicatrix is the term applied to the resulting appearance in the skin after the loss of its substance, together with the deeper tissues. It is due to the formation of firm, fibrous tissue and its subsequent contraction, as in the repair of a wound. The wound may be superficial and only affect the epidermis, and may entirely disappear; or it may be deep, and destroy the true skin and deeper tissues. The scar which follows in the latter case will be well marked, and generally resembles in shape the wound which was inflicted, or it may become smaller and narrower.

All scars run through two distinct stages, that of inflammatory redness and that of brown discoloration; and when the destruction is considerable or the inflammation high a third condition may be seen, namely, bleaching. The first stage lasts during the period of healing, two, three, or four weeks; the brown or coppery stage from a few months to a year; the white is permanent.

In examining a scar carefully measure it, note its color and the condition of the surrounding tissues, observe whether it is on a level with or sunk below the surface, and its mobility in relation to surrounding tissues. It may be mentioned that a considerable bleached area of the skin, such as occurs sometimes in negro races, resembles a superficial scar; but if the surface is carefully examined for lanugo or the fine downy hairs

found on most parts of the body, their presence will decide the question, as there are no hairs in scar tissue. With regard to scars produced by such means as setons, cupping, venesection, vaccination, pitting from smallpox, an operation on a boil or carbuncle, etc., the position, shape, size, and appearance would readily indicate the causation, and these are generally known even to the laity.

The brown discoloration following herpes is a fair illustration, as no other scars would so closely follow the distribution of a nerve.

With regard to scars caused by wounds of any kind, each case must be taken on its merits; but as much depends on exact description in proving the identity of a person, such description should be most accurate. Many cases are on record, and can be easily studied. The identity of a mutilated woman in a well-known English case was decided by an oblique scar on the wrist caused by a cut from a bottle. In the Wainwright case, where the mistress, Harriet Lane, was shot by her paramour and the body buried in quicklime, the identity was established a year later by the presence of a scar on the anterior aspect of the shin. The scar was caused by a burn. A preparation of this scar is still in the Black Museum at Scotland Yard.

Tattoo marks would form a very decided indication of the identity of a person, if the design was previously known to friends. Their presence or absence may be of the greatest importance, as in the Tichborne case. (*Vide* Identity of the Living.) It is a very usual habit for a man, especially a sailor, to have his own initials tattooed. An American sailor would be more likely to have a flag with the stars and stripes than the tricolor of France. Moles, birth-marks, nævi of all kinds should be described as to locality, shape, color, etc., as such marks are usually known to intimate friends and relatives, and may prove of great value in identification. It is not necessary to do more than mention these *en passant*.

In addition to true cicatrices there are two appearances which resemble slightly superficial scars, for instance:

If a finger-ring be worn for any length of time, there is a well-marked depressed line made by the ring. This is paler than the surrounding skin, as it is unexposed to the air, and unless made by a wedding-ring has generally some irregularity in outline according to the design of the ring, e.g., a signet-ring. The mark made by a wedding-ring in European countries is a slender, even-defined circular mark around the left fore-finger. A signet-ring is usually worn on the fifth finger. Another mark is that made by the garter on the legs of a woman. This may be above or below the knee, and is best seen below. It is more customary to find this mark among the lower classes, and is usually below the knee, I believe because the richer classes wear suspenders or garters above the knee. This may be a means toward establishing identity.

7. **Deformities.**—It would seem a simple matter to identify a corpse by a deformity, such as a curved spine or the various forms of talipes, and this is no doubt the case; but in smaller deformities, such as the loss of a finger or contraction of a joint, confusion often arises. A case in point happened in London in 1889, where the body of a man was found drowned, and was identified by the relatives on account of a curiously contracted ring-finger, and while the inquest was being held the real man appeared, showing precisely the same physical condition. One point is, however, clear, and it is that any deformity found in the dead body,

whether of head, spine, or limbs, is real, but it is by no means uncommon for deformities to be feigned by "old soldiers"; but this is beyond our inquiry. Among malformations to be described may be mentioned shortening of limbs, spinal curvature, talipes, imperfect conformation of the genitals, anchylosis and contraction of joints, polydactylism, whether of hands or feet, or the absence of one or more members.

8. Occupation, etc.—In the examination of a corpse some aid toward identity may be obtained by carefully observing if there are any marks on the body or limbs which are the results of the occupation followed during life. These would be found, in most instances on the bodies of manual laborers, or those exposed to wind and weather, such as sailors, soldiers, engineers, etc., rather than on the studious or wealthy classes, who are protected from such influences. The delicacy of the skin, especially the softness of the palms of the hands, the care taken of the nails, the trimming of the hair in either sex, would sufficiently indicate that the body is that of a person in a good position in life.

With regard to outdoor workers, the face of a sailor or a soldier is generally well tanned by the sun, in the case of sailors the tan reaching down the neck to the chest, where it is seen as a triangular patch with the apex downward. In the case of the soldier the tan is over the face and neck only, while the forehead is often obliquely marked by the wearing of the cap on one side, and the chin-strap may protect a part of the cheeks and chin from the sun, and so its position is known by a paler color. It may here be noticed that among the colored races in India, in some instances, one arm and shoulder and part of the breast is exposed, while the other is covered, the two being separated by a well-marked oblique line of a lighter shade.

The palms of the hands of laborers and outdoor workers are hardened, and generally there are hardenings at the base of the fingers over the heads of the metacarpal bones from grasping weapons or tools of various kinds. (See Identity of the Living.) Other callosities may be produced by certain occupations where constant pressure is made upon a part. In India these callosities are found on the feet—sometimes on the outside of the foot, sometimes on the dorsum, according to the sect; while sometimes there is a distinct mark on the forehead of a Mohammedan, from striking the head on the ground as he bows toward Mecca. Stains on the fingers again may be of help. These are found in those working in chemical factories or laboratories, or in dye-works, and are produced by acids or dyes of various kinds; nitric acid, for instance, leaving a yellow, while sulphuric acid leaves a blackish, stain, and nitrate of silver leaves also a black stain. Other occupations may be discovered by the presence of skin affections, such as the washerwoman's eczema on the back of the hand, and the so-called baker's itch, also on the hand.

In regard to muscles, it may just be mentioned that blacksmiths, engineers, and prize-fighters have the upper part of the body developed more strongly than the lower. The well-formed calf of the ballet-dancers is another well-known instance of muscle hypertrophy from occupation.

With regard to the effect of pressure by dress, the marks of tight lacing are well seen, the waist being much narrowed and the organs displaced, the liver and stomach sometimes being close to the pelvis.

Corns on the toes and bunions are often the result of a short tight shoe with pointed ends, and more often remarked in women's feet. The hands of the well-to-do are generally soft and white from wearing gloves.

All these points should aid in giving an idea of the occupation of an unknown person, no single point being sufficient in itself.

The presence of foreign substance, such as hay, straw, grains of wheat, flour, animal hairs, or human hairs differing from those of the deceased, may be an important help toward finding out both the occupation and identity of the deceased. For instance, a coachman would more likely have horse's hairs on his person or dress, and a baker would more likely have flour. In one case a murder of a girl preceded by rape was traced to a miller, in consequence of some grains of wheat being found on the girl's person and underclothing.

Hairs are appendages of the skin, and are modified epithelium. Each hair consists of a bulb—which is the dilatation of the hair fixed in a depression in the skin called the hair-follicle—a shaft or stem, and a point. The stem is generally cylindrical, or more or less flattened, the section of a hair in the straight-haired races being circular, in the woolly-haired smaller and oval. The stem is covered by finely imbricated scales, the edges of which give rise to a series of fine, waved, transverse lines, and these are the lines which are so characteristic in different animals.

Internal to this is a fibrous substance consisting of fusiform fibers with more or fewer pigment-granules and diffused coloring matter. Internal again is the medulla or pith, though it is not present in all hairs. This is formed of cubical cells with air-bubbles among them; the presence of the air-bubbles gives a dark appearance on transmitted light, but a white appearance to reflected light. The bulbous extremity which fits in the depression of the true skin called the hair-follicle is lighter and softer than the stem. The point of the stem tapers, and is free from a medulla.

Human hairs have a diameter of 1–170 inch to about 1–3000, the female hairs being larger and from 1–2500 to 1–3000 inch less in diameter, except on the pubes, where the male hairs have a smaller diameter.

Human hairs may be distinguished from animal hairs by the fine, wavy, transverse lines of the cortex, which are more marked in man than in any other mammal. The size of the hair of the deer and horse is greater than that of man, and there is in these animals a greater development of the medulla at the expense of the cortex.

In man and monkey the pigment is confined to the cortex, while in the rodent it is found in the medulla.

Diameters.

Hair from young girl's arm	1–1666
Hair from head (female)	1–34
Hair from pubes (female)	1–166
Hair from beard	1–166
Hair from head (male)	1–333
Hair from pubes (male)	1–233
Deer	1–250
Horse	1–340
Fox	1–600
Dog	1–1100
Rabbit	1–1125

The value of photography has already been commented on, and its use is becoming of daily increasing importance. Careful photographs are taken of every unknown body examined by the medical examiners in Boston, and they prove of the greatest value.

We have now discussed in somewhat the form of an essay the various points of importance in the identification of the dead, and have given several rules for guidance of the students in this inquiry. We add a tabular statement of the points to be observed, and conclude by giving in detail four cases, illustrative of many of these points.

TABULAR STATEMENT OF DETAILS TO BE NOTED IN THE EXAMINATION OF BODIES, OR OF PARTS OF BODIES, OR OF BONES IN THE QUESTION OF IDENTITY.

1. The surroundings and conditions of parts found.
2. Height.
3. Weight.
4. Probable age, considering teeth, maxillæ, skull, fontanelles, centers of ossification, and condition of ephiphyses.
5. Sex; genital system and breasts; general shape, hair, pelvis bones.
6. Deformities.
7. Marks on skin, including scars, tattoo marks, signs of previous disease, such as scrofula, syphilis, smallpox, skin diseases, nævi, moles, warts.
8. Injuries, wounds, fractures, dislocations.

After this examine in detail the various parts and organs of the body.

1. Head and features.
2. Neck.
3. Chest.
4. Pelvis.
5. Extremities.

Mutilated Remains.

1. Accuracy of the fitting of the various parts.
2. Nature of mutilations, whether the soft parts were cut with blunt or sharp knife, or done with or without skill; whether the bones have been chopped or sawn by coarse or fine saw.
3. Whether they have been burned, boiled, acted on by chemicals, or buried in earth or macerated in water.

The following cases, which came under the observation of Dr. Hebbert in London, are cited *in extenso* for the purpose of illustrating many of the points alluded to in the preceding part of this article.

CASE I.

In July, 1887, Mr. Bond was requested by the treasury to examine some remains found in various parts of London, and I had the opportunity of helping at the autopsy. All the portions were found either in the Thames or in the Regent's Canal, and consisted of eight separate parts. In the inquiry we had to determine the following points: whether they were human and belonged to the same body, the race, age, sex, height, complexion, and condition of life, and, if possible, the cause of death, and the skill or ignorance of the operator.

The parts were: (*a*) the lower part of the thorax and the upper part of the abdomen, from the fifth dorsal vertebra to the third lumbar vertebra; (*b*) the pelvis below the third lumbar vertebra; (*c*) the right thigh, including patella; (*d*) the left thigh; (*e*) both legs and feet, the left having patella attached; (*f*) the arms from the shoulders to the fingers. They were obviously human, and on applying the various joint and bone surfaces together we found that they fitted. The skin-cuts apparently corresponded, but had been too much altered by decomposition to warrant

a certain opinion. The limbs were muscular, and the remains generally had a fair amount of subcutaneous fat.

The various parts were then described in the report. First, the thorax had been cut above, through the body of the fifth dorsal vertebra, and below, through the body of the third lumbar vertebra, the bones having flat but somewhat rough surfaces, and through the skin and other tissues by a series of more or less clean-cut incisions, so that the fourth left rib and the fifth right rib had been left, and the sternum below the articulations of these ribs. The diaphragm was intact, but the lungs, heart, and other thoracic viscera were absent. Below the diaphragm were the liver, stomach, both kidneys, and spleen; the remaining viscera of the abdomen were included in the pelvis below the third lumbar vertebra.

The lower piece of the trunk was the abdomen from the third lumbar vertebra and the pelvis. No part of the small intestine from the duodenum was found, nor the large intestine, except the sigmoid flexure and rectum in the lower fragment. In the pelvis were the uterus, vagina, ovaries and appendages, and the bladder. The acetabula were empty, the thighs being separated from the pelvis by incisions passing around the flexure of the joint. The external organs of generation were those of a female. The uterus measured three and one eighth inches, the body one and one half inches, and the cervix one and five eighth inches. The os internum was well marked, and the arbor vitæ very distinct. The os externum was small, and would barely admit the point of a sound. The ovaries were small, and one showed a corpus luteum of menstruation. The rugæ of the vagina were prominent. On the pubes were some black hairs. An incision had evidently been made from the ensiform cartilage to the pubes. There was no trace of ecchymosis in the skin of the incisions separating the limbs or those dividing the trunk.

The skin of the two pieces of the trunk was partly decomposed and sodden, but was evidently fair in color.

The arms had been taken off at the shoulder by incisions passing obliquely downward and outward from the tip of the shoulder around the axilla, so as to leave most skin on the upper and outer aspect of the arm. The heads of the humeri had been cleanly disarticulated. The skin of the arms was peeling off, and that of the palms thick, white, and sodden; the two terminal phalanges of the fingers, with the exception of the thumb and the left ring-finger, had rotted off. The length of the left arm and hand was twenty-five and three-eighth inches. There was no circular depressed mark on the left ring-finger.

The thighs had been cut off at the hip-joint by cuts around the flexure of the joint, and the heads of the femora disarticulated. The right thigh had the patella attached, but was separated from the leg at the knee-joint. The left thigh, which was found at a later date, showed not only more signs of decomposition, but the head of the femur was riddled with the small circular holes of a water worm. The femur measured sixteen and one eighth inches from the head to the lower level of internal condyle.

The legs, including the feet, had been cut off by circular cuts from the center of the knee-joints, the left leg having the patella attached. The legs were well shaped and muscular, and the foot small and without deformity. There were circular, slightly depressed marks, about half an

inch deep, just below the knees. Each leg with the foot measured sixteen inches; right and left tibiæ, thirteen inches; right and left fibulæ, thirteen inches. The skin of the thighs and legs was decomposing, the cuticle in places being raised in bullæ and peeling off. The cuticle of the feet had disappeared with the nails, and the terminal phalanges had fallen off.

The following inferences were then drawn from the foregoing facts:

1. *The sex* was easily told, as the external organs of generation, as well as the uterus and ovaries, were present.

2. *The age.*—The union of the epiphyses proved the age was over twenty-five.

3. *The complexion* was dark, as shown by the pubic hair, while the fair skin proved Caucasian origin.

4. *Height.*—The length of the arm being $25\frac{3}{8}$ in., by doubling this and adding 12 in. for clavicles and sternum we should have a result of 5 ft. $2\frac{3}{4}$ in. The length of the lower extremity was $32\frac{1}{8}$ in. $\times 2 = 64\frac{1}{4}$, i.e., 5 ft. $4\frac{1}{4}$ in. By measuring the ring-finger the length was $3\frac{1}{4}$ in. $\times 19 = 5$ ft. $1\frac{1}{4}$ in., so we had to average the three measurements, and calculate her as about 5 ft. 3 in. in stature.

5. *Condition of Life.*—The skin of the hands and feet was too much decomposed to show whether she had led a life of hard manual work. There was no mark made by a wedding-ring. The uterus was that of a virgin, but the vulva was too decomposed to give indication with regard to old or recent injury. The mark around the leg showed that garters were worn below the knee—a custom, I believe, more common among the lower than the upper classes, who either wear garters above the knee or suspenders. She had recently menstruated.

The cuts on the surfaces of the vertebræ were such as would be made by a saw, and the long clean sweeping incisions through the skin showed that a very sharp knife had been used. The disarticulations were neatly and cleanly done, in each case the joint being exactly opened. The absence of ecchymosis showed that all the cuts were made after death.

It was obvious, from the direction and manner of the cuts, that no ordinary surgical or dissecting-room operation had been carried out. Although no special knowledge of anatomy was shown, the cuts indicated a practical skill in amputating limbs at joints, and making clean sweeping skin cuts. It may be argued that such skill would be gained by a hunter or a butcher, as either of these are in the habit of rapidly and skilfully separating limbs, and of cutting up a trunk into several parts. I do not think that any surgeon or anatomist could have done the work so well, as they are not *constantly* operating, while a butcher is almost daily cutting up carcasses. Moreover, the limbs were separated in almost precisely the way a butcher or hunter would adopt, i.e., making a series of cuts around the flexure of the joint, and then by a strong twist wrenching out the head from the joint, and cutting the capsule.

The condition of the skin showed that each part had been lying and decomposing in water, and that several months had elapsed since the date of death.

The summary was that the remains were those of an adult female of Caucasian origin and dark complexion, from twenty-five to thirty-five years old, and about 5 ft. 3 in. high, that she had not borne a child, and in fact, from the small size of the os uteri, was unlikely to conceive; that

the body had been mutilated *after* death by some person who, though not necessarily a skilled anatomist, yet had some knowledge of joints and the readiest mode of separating limbs, and by inference a butcher or hunter; that decomposition had taken place in water, and some months had elapsed since death.

Case II. September 16, 1888.

"(*a*) On this date I examined a right human arm, separated from the trunk at the shoulder by an incision passing obliquely around the upper third of the humerus, so that the lowest point is internal and five inches vertically from the head of the humerus, and the highest point external and two and three quarter inches vertically from the head of the humerus.

"(*b*) The head and neck of the humerus are exposed, the capsule of the joint having been cut circularly and the head enucleated. The cartilage shows two or three small nicks. The amputation has been made by seven separate cuts, cleanly dividing the tissues.

"(*c*) *Description.*—The arm is large, shapely, and muscular, but has rather the roundness and general contour of a female than the muscularity, as shown by the development of the triceps and biceps, of a male limb. The wrist is small, the hands long, with tapering fingers; the nails are small, flat, and well formed, and have been carefully trimmed. The fingers of the hand are firmly flexed and stiff, and the thumb opposed and flexed. In dissecting the limb it is found that the flexion of the fingers is due to the rigor mortis of the flexores digitorum.

"(*d*) *Skin.*—The skin of the arm is adherent and white, though there are several patches of brown color and of a hard leathery consistence from decomposition. There is some fine downy hair on the back of the forearm, not thick and strong as in a man. There are no bruises nor cuts nor old scars. The skin of the hand is thick, white, and much corrugated, in some places the epidermis being raised from the cutis vera. The nails are firmly adherent. There is no circular depressed mark on the fingers.

"(*e*) *Hair.*—There are a few hairs in the axilla, of a dark brown color.

"(*f*) *Weight.*—7 lb. 6 oz.

"(*g*) *Measurements.*—Length of the whole arm from head of humerus to tip of middle finger, 31¼ in.; the measurements along both flexor and extensor aspects corresponding. Length of forearm from tip of olecranon to tip of middle finger, 18 in. Humerus from external condyle to great tuberosity, 12¼ in. Humerus from head to internal condyle, 12⅞ in. Ulna from tip of olecranon to styloid process, 10¾ in. Hand from third metacarpal bone to tip of finger, 7½ in. Third finger from tip to point on first phalanx, which meets a line drawn transversely from root of the thumb-nail, 3⅝ in. Circumference of arm just below the lower end of incision, 13 in. Circumference five inches above internal condyle, 12¼ in. Circumference of forearm one inch below tip of olecranon, 10⅝ in. Wrist, 6⅜ in. Hand, 8⅛ in.

"(*h*) *Ligature.*—Surrounding the arm six inches above the internal condyle is a piece of string, tightly tied; this string is partly wrapped in paper (newspaper). The mark made by the string is circular, and shows the strands of the ligature. The skin below the string is parchment-like in character, but there is no ecchymosis.

"The tissues divided by the amputation show no clotting nor ecchymosis. The veins are full of black fluid blood, which has been kept in by the ligature.

"(*i*) *Disease.*—There is no disease of the joint or limb.

"(*j*) *Age.*—The epiphyses of the humerus are firmly united to the shaft, and also that of the fourth metacarpal bone. These unions occur from the eighteenth to the twentieth year.

"*Height.*—The height is suggested by three methods:

"(*a*) Twice the length of the arm plus ten inches for the clavicles (or less in the female) and one inch for the episternal notch. This would give $31 \times 2 = 62 + 10 = 72$, which is probably several inches too much.

"(*b*) The length of the third finger from the tip to a point meeting a line, drawn transversely from the root of the thumb-nail, is $\frac{1}{19}$ part of the height. $3\frac{5}{8} \times 19 = 68\frac{5}{8} = 5$ ft. $8\frac{5}{8}$ in.

"(*c*) The length of the forearm from the tip of olecranon to tip of third finger equals $\frac{5}{19}$ of the height; this is: $18 \times \frac{19}{5} = 68\frac{2}{5} = 5$ ft. $8\frac{2}{5}$ in.

"*Inferences. Date of death.*—The appearance of the hands would suggest maceration in water from three to four weeks, and the absence of ecchymosis proves that the limb was separated after death.

"*History.*—The limb is clearly not separated by the ordinary surgical operation at the shoulder-joint, for the following reasons:

"1st. The incision of an ordinary operation by transfixion has the lowest part outside and the highest inside for the formation of the flap; and if by the double flap methods, the longest piece of skin is taken from the outside of the arm.

"2d. The entire absence of disease, either of joint or limb, such as would warrant an operation.

"3d. The separation took place *after death.*

"It certainly shows no trace of having been prepared for the dissecting-room, as there is no injection in the vessels, nor sign of preservation by antiseptics."

The general shape and appearance of the hand and arm suggested at once a female limb, the taper fingers, the small wrist, and the absence of any special peculiarity all favoring this view; the neat appearance of the nails, and the absence of any deformity by occupation, were against a low-class person.

The manner in which the limb had been separated was exactly the same as in the first case, and similar arguments as to the occupation of the operator will apply in this case.

"*Summary.*—The limb is apparently that of a female adult above twenty years of age, of Caucasian race, of dark complexion, and about 5 ft. 9 in. in height.

"It has not been separated by the ordinary surgical operation during life, but has been cut off after death by a person with some knowledge of anatomy.

"The ligature was either tied around to prevent the bleeding from the veins, or to fix a newspaper wrapper around the limb. In either case it had the result of preventing the draining out of the blood.

"Decomposition had begun after maceration in water."

A few days after this a portion of the trunk was found in Whitehall, and was examined by Mr. Bond and myself. It consisted of the whole

thorax and the upper part of the abdomen as far as the fourth lumbar vertebra.

Description.—The trunk is that of a female, the breasts being present. It comprises the thorax and upper part of the abdomen, the head having been separated at the sixth cervical vertebra, and the pelvis and lower part of the abdomen at the fourth lumbar vertebra. The bones have been cut through the middle of the bodies, showing flat, somewhat rough surfaces. The skin incisions have clean, well-defined edges. There is a fair amount of subcutaneous fat, and the muscles are large and well developed.

Measurements.—Length, 17 in. Circumference of thorax at level of nipple line, 35½ in. Circumference of waist, 28½ in.

Surface.—The skin is fair, and not much decomposed. The breasts are large and prominent, with small, well-shaped nipples. There are no scars nor wounds, but there are impressions made by the string with which the trunk was tied. These are four in number, two running down obliquely from the shoulder and two crossing the chest, one at the level of the nipples and one across the upper part of the sternum. The divided surfaces are much decomposed, and the parts full of maggots. There are no appearances of lineæ albæ on the surface of the abdomen.

Cut Surfaces. Arms.—The arms have been amputated at the shoulder-joints by several incisions passing obliquely downward and outward from the tip of the shoulder around the axilla. The glenoid fossæ are bare, and the limbs cleanly disarticulated.

Neck.—The skin of the neck has been divided opposite the cricoid cartilage by two clean lateral cuts, joined in front and behind by several small, jagged incisions; the posterior plate of the cricoid and the body of the sixth cervical vertebra have been sawn through. The tissues of the neck on either side are in an advanced state of decomposition.

Organs. Breast.—The mammary glands are large and healthy. On opening the thorax it is noticed that the rib cartilages are unossified.

Heart.—The substance of the heart is healthy, the valves normal, and there is no staining of the endocardium of either ventricle.

Lungs.—The left lung is free from adhesions, and the substance healthy. The right lung is firmly adherent to the chest wall and diaphragm by old adhesions; the substance appears healthy.

The liver, spleen, and kidneys are normal.

Stomach contains about one ounce of partially digested food.

Intestines.—The small intestines, with the mesentery, are *in situ*, and appear healthy. There are a few remains of the transverse ascending and descending parts of the colon, but the lower parts are absent, as well as the pelvic viscera.

Hair.—There are a few dark-brown hairs in the axilla.

The clavicle measures six inches, and the sternum six inches. The sternal epiphysis of the clavicle is united to the shaft.

Comparison with Arm.—The arm discovered in Pimlico and examined on the 16th of September was brought to the mortuary, and found to exactly correspond to the trunk. The skin incisions fit, and the bones, i.e., the humerus and scapula, evidently belong to the same joint. The hair taken off the arm and the hair from the axilla of the trunk are identical.

Summary.—The trunk is that of a large, well-nourished woman, of an

age of full sexual activity, as shown by the breasts. It could not be decided whether she had been a mother, but the appearance of the breasts would indicate that she had not suckled children. The trunk had been mutilated after death, and the death had probably occurred about two months previously. Decomposition had taken place in the air, as shown by the presence of maggots.

A fortnight after this a left leg and foot were found. The skin was incrusted with earth, and partly covered with mold. The cuticle of the sole of the foot and toes, with the nails, had nearly separated. The nails were well shaped and properly trimmed. The skin of the leg was fair, and not much altered by decomposition.

The limb had been separated from the thigh at the knee-joint, the patella being absent. The incision had clean and well-defined edges, and the joint exactly opened.

The length of the leg was $17\frac{1}{8}$ in.; circumference of calf, 14 in.; ankle, $8\frac{1}{8}$ in.; length of foot, $9\frac{1}{2}$ in. On the outside of the leg was a dark purple mark the size of a shilling, and the tissue beneath contained clotted blood. A small but similar mark was on the inside of the leg.

The length and size of the leg and foot pointed to its being part of the same body. The marks were ante-mortem bruises. The date of death was from six weeks to two months previously.

The remains showed various kinds of putrefaction: the arm had been in the water, the trunk exposed to the air, and the leg buried.

As will be gathered from the description, the arm in the second case had been cut from the trunk in a precisely similar manner to that in the first case; in fact, as soon as I saw the arm I was struck by the close resemblance of the modes of separation, and the mutilation of the trunk was in every respect identical.

Case III.

The parts found were: (1) two large flaps of skin, the uterus and placenta; (2) both arms and hands; (3) both thighs; (4) both legs and feet; (5) the trunk divided into three parts.

The Trunk.—The first portion of the trunk included the shoulders and the upper part of the back; the head and neck had been taken off opposite the sixth cervical vertebra; the skin, muscles, and vessels were divided cleanly by a series of cuts; the cricoid cartilage was cut through, and the body of the sixth cervical vertebra divided through the center, showing a flat and somewhat rough surface. The edges of the skin and the section of the vessels were sharply defined. This part was separated from the trunk below at the junction of the seventh and eighth dorsal vertebræ.

The chest had been opened in front by the mid-line, the upper part of the sternum cut through, and the contents of the chest had been removed.

Both arms had been taken off opposite the shoulder-joints by three or four long, sweeping cuts, the joints neatly disarticulated. Decomposition had not far advanced; the skin was white and sodden, the epidermis peeling off in places. The second portion of the trunk included both breasts and the upper part of the abdomen as far as the intervertebral substance between the third and fourth lumbar vertebræ. The upper

surface of this portion exactly fitted the lower surface of the former part. It had also been opened down the center of the sternum.

The ribs from the fourth downward were present; the lower border showed a clearly defined skin margin from the back at the junction of the third and fourth lumbar vertebræ to a point an inch and a half above the umbilicus on the left side, and a point just below the umbilicus on the right side.

The intestines had been removed, but the duodenum and a piece of the stomach remained. There were also present both kidneys, the spleen, pancreas, and liver. The breasts were firm and compact, and enlarged; the areolæ well marked, and follicles distinct. All the organs found were healthy. The liver was much decomposed.

The third portion of the trunk consisted of the pelvis from below the third lumbar vertebra. The thighs had been taken off opposite the hip-joints by long, sweeping incisions through the skin, muscles, and tissues down to the joint, the heads of the bones neatly disarticulated. The incisions separating both the arms from the upper piece, and the thighs from the lower piece, were exactly opposite the flexure of the joints. The pelvis contained the lower part of the vagina and the lower part of the rectum, the front part of the bladder including the urethra. The vagina was flaccid, the mucous membrane healthy, and still showing rugæ. There was no rupture of the vaginal walls or fourchette, nor was there any swelling nor congestion of the parts.

The flaps of skin and subcutaneous tissues consisted of two long, irregular slips taken from the abdominal walls. The left piece included the umbilicus, the greater part of the mons veneris, the left labium majus, and labium minus. The right piece included the rest of the mons veneris, the right labium majus and minus, and part of the skin of the right buttock. These flaps accurately fitted together in the mid-line, and laterally corresponded to the incisions in the two lower pieces of the trunk. The skin was fair, and the mons veneris was covered with light sandy hair. There were no appearances of lineæ albæ. The upper part of the vagina was attached to the uterus, both ovaries and broad ligaments were present, and the posterior wall of the bladder. The uterus had been opened on the left side by a vertical cut, six inches long, through the left wall. The organ was much dilated, the vessels on the inner surface large and open, and the mucous membrane swollen and softened. The uterus measured 10 in. long by 7½ in. wide. The circumference of the os externum was 4 in. The length of the cervix from the os externum to the os internum was ¾ in. Inside the uterus were the placenta, cord, and membranes. The cord measured 8 in., and the distal ends showed a clean cut. The vessels contained fluid blood. The placenta was circular, and measured 6½ in. in diameter. The ovaries were irregular and shriveled, the right containing a cyst.

The Arms.—The arms had been removed from the trunk at the shoulder-joint; when the upper ends of the arms were placed against the shoulders of the trunk it was found that the joint surfaces corresponded, and that the margins of the skin accurately fitted; the two limbs were identical in appearance and measurements. The skin of the hands was white and much corrugated, and the epidermis peeling off; the nails were still adherent. The nails were short, the edge much below the tip of the finger, with an irregular outline. There was no thickening of the

skin of the palm or fingers. The hair in the armpit was similar in color to that on the pubes. On the upper and outer side of the left arm were four round superficial cicatrices. On the back of the left ring-finger was a small discoloration, a quarter of an inch broad; this, when cut into, showed extravasation of blood in the tissues. On the inner side of the left forearm, about one inch above the wrist, there was an irregular, white, hard cicatrix one inch long and a quarter of an inch wide. There was a small bruise over the internal condyle of the left arm, and another one just below the right internal condyle.

Measurements.—Whole length of arm and hand, $26\frac{7}{8}$ in.; from the elbow to tip of middle finger, $16\frac{1}{2}$ in. Length of middle finger, $3\frac{1}{4}$ in. Length of hand, $6\frac{3}{4}$ in.; breadth of hand, $3\frac{1}{4}$ in. Circumference of wrist, $5\frac{3}{8}$ in. Circumference of palm, 7 in. Humerus, great trochanter, and external condyle, $10\frac{3}{4}$ in. Head, to internal condyle, $11\frac{1}{4}$ in. Ulna, to styloid process, $9\frac{1}{4}$ in.

Lower Extremities.—Thighs: On placing the upper ends of the thighs to the hip-joints of the pelvis, the heads of the femora exactly fitted the cotyloid cavities, and the margins of the skin corresponded. The legs had been removed at the knee-joint, the left thigh having the patella attached, and also the semilunar cartilages. The length of the femur from the head to the internal condyle was 17 in.; the circumference at the knee-joint, 13 in.; and the maximum circumference, $19\frac{1}{2}$ in. At the inner side of the upper part of the thigh were some light sandy hairs similar in color to those on the pubes. The skin was fair, not decomposed, and the tissues were fresh. The right thigh exactly resembled both in measurements and condition the left.

Legs: On placing the lower ends of the thighs against the upper ends of the legs, the joint surfaces and the cuts in the skin were found to fit. The leg and foot measured $16\frac{1}{2}$ in. The tibia was $13\frac{1}{2}$ in. long; fibula, 13 in. long; foot, $9\frac{1}{2}$ in. long. The circumference of the left calf equals $13\frac{1}{8}$ in., of the right, $13\frac{7}{8}$ in. There was no deformity of the toes, and the feet were well shaped. The whole length of the lower extremities equals $32\frac{7}{8}$ in.

Epiphyses.—The sternal ends of the clavicle had recently joined, but the line of the union was still evident, the tips of the acromial processes of the scapulæ had not joined the spine. The upper ends of the fibulæ had firmly united.

The following inferences were then drawn from the foregoing facts.

Sex.—The sex was female. The uterus was that of a pregnant woman, and the size of the uterus as well as that of the placenta would indicate that the pregnancy had advanced to between six and seven months. The measurement and appearance of the os and the length of the cervix showed that delivery had not taken place, but the fœtus had evidently been removed through the incision in the left wall of the womb. The condition of the vagina and the non-rupture of the fourchette confirmed this view.

Age.—The complete union of the epiphyses of the fibulæ proved her age to be over twenty-four years, while the not complete union of the acromial processes and the sternal ends of the clavicle showed she was under twenty-five. The complexion was fair, as shown by the hair.

Height.—Twice the length of the whole lower extremities equals $65\frac{3}{4}$ in. The length of the forearm, $16\frac{3}{4} \times \frac{19}{5} = 63\frac{13}{20}$. Length of middle

finger, $3\frac{1}{3} \times 19 = 63\frac{1}{3}$ in. Twice the length of the arm $= 53\frac{3}{4} + 11$ in. for the clavicles and sternum $= 64\frac{3}{4}$ in.

Incisions.—The surfaces of the vertebræ are such as would be made by a fine-toothed saw. The clean edge of the skin incisions showed that a very sharp knife had been used. The joints in each case, with the exception of the left knee, were exactly opened, and the limbs neatly disarticulated. In the case of the left knee the semilunar cartilages were attached to the ends of the femur.

Condition of Life.—There was no thickening of any portion of the skin of the hands which would suggest any special occupation. The bruise on the back of the left ring-finger might have been made by the forcible removal of a ring. There was no mark either on the thighs or the legs, as is made by the pressure of a garter. It was clear from the direction and manner of the cuts that no ordinary surgical or dissecting-room operation had been carried out, but the system of division of the parts gave evidence of design and skill—the design probably being for the purpose of concealment of the crime and easy carriage of the parts; the skill not showing the anatomical knowledge of a surgeon, but rather the aptitude learned by a butcher, horse-knacker, or other person used to deal with dead animals and to readily separate limbs at the joints.

All the parts evidently belonged to the same body. The state of decomposition of the various pieces is consistent with the theory that death took place about twenty-four hours before the discovery of the first two portions.

Summary.—The summary was that the remains were those of an adult female of fair complexion, with light sandy hair, well formed and well nourished, from twenty-four to twenty-five years old, and about 5 ft. 4 in. in height; that she was pregnant of about six to seven months' duration; that she was undelivered when death took place, and that the fœtus had been removed by an incision through the walls of the uterus after death; that the mutilations were carried out after death by some person with a considerable technical knowledge of the speediest mode of cutting up animals; that decomposition had taken place, partly in water and partly in the air; and that death occurred about twenty-four hours before the first discovery. That an injury had been suffered to the left forearm which left a permanent cicatrix.

The great interest in this case was that the foregoing inferences were verified by the identification of the woman. She was proved to be an unfortunate, named Elizabeth Jackson, who was in her twenty-fifth year, measured 5 ft. $4\frac{1}{2}$ in. in height, and was known to be far gone in pregnancy.

The verification of the remains was confirmed by the cicatrix on the left wrist, which was caused by a fall on a broken bottle some years previously. She was last seen two days before the discovery of the remains.

With regard to the height, the various calculations do not exactly correspond, but the average of the four would give a little over $64\frac{1}{4}$ in., so that the inference was very near the exact truth.

This case is remarkable from the fact that, beginning with one limb only, the other parts of the body were found. The adoption of four different methods was pursued in estimating the height. Each method gave a result within an inch; and then, taking the mean of the four measurements, we arrived at the actual height as described by the persons who identified the body.

CASE IV.

This case was that of a trunk found under an archway in Whitechapel, and on September 11, 1889, I was present at the post-mortem examination, and made the following report to the police.

The remains consisted of the trunk and arms of a female body. The head had been cut off at the lower part of the neck, and the thighs had been separated at the hip-joints.

The trunk was plump and well formed, with full breasts, fair skin, and dark-brown hair on the pubes and axillæ; the arms well shaped, hands small, and nails well kept. The weight of the trunk could not be taken. The length was 26 in., and circumference of chest at nipple-line 34 in., and below breasts, 31¾ in.

Rigor mortis had passed off, and decomposition, as shown by green discoloration of the abdomen, just beginning. The cut surfaces at the hips were black and dry, but the surface at the neck moist and red. The skin and muscles of the abdomen had been cut by a vertical incision, running from two inches below the ensiform cartilage downward, and ending on the left side of the external genitals, just opening the vagina, but not opening the peritoneal cavity. There were a number of small round bruises on the forearms and arms, most on the inner surface of the forearms, and varying in size from a shilling to a sixpence. On the left wrist were two cuts, one just grazing the skin, three quarters of an inch long, and the other cutting through the skin, and one inch long. There was no ecchymosis on the edges, and no gaping of the wounds. There are no lineæ albæ on the abdomen, and no further scars or injuries.

The incisions separating the head were apparently two in number: the first beginning behind, opposite the spinal column, and ending in front on the right side, and carried from left to right; the second beginning on right side in front and carried to back, joining the first, but leaving a tongue of skin behind. There was no ecchymosis in the skin. The muscles and tissues down to the spinal column were cut on the same level, the cricoid cartilage being cut about the center. The spinal column was divided at the junction of the fifth and sixth cervical vertebræ, through the intervertebral substance, just a thin shaving of the body of the fifth cervical vertebra being left. The ends of the vessels were very clean cut. There was no retraction of the muscles or other tissues.

The thighs had been separated at the hip-joints, the skin cut through by two or three sweeping, circular incisions, beginning apparently just below the hip-bone, and carried downward and inward around the buttock. The capsules of the hip-joints were opened, and the heads of the bones neatly disarticulated.

There was no retraction of the muscles and tissues, and the incisions, both at the hip and neck and in the abdomen, had very clear-cut edges.

The internal viscera were then examined.

Heart.—The walls were flaccid, the ventricles empty and dilated; the valves healthy and competent, the muscle pale and fatty. On the pericardium was a patch of old inflammation. Weight, 9½ oz.

Lungs.—Right upper lobe adherent to pleura by old firm adhesions. Left lung free. Both lungs were apparently healthy, but were beginning to decompose.

Spleen large, soft, decomposing; 7½ oz.

Liver.—Weight, 50 oz.; decomposing, substance fairly healthy.

Kidneys.—Weight, 7 oz. each; slight decomposition, substance fairly healthy.

Stomach.—Walls normal, with healthy mucous membrane. About a dram or so of partly digested food, which appeared to be plums; there was no odor of the contents.

Intestine.—The large intestine contained fæces. There was no abnormality in either large or small gut.

Vulva.—The vulva is patent, and there is no hymen. The fourchette is unruptured. The vagina is wide, but still rugose. The mucous membrane is healthy.

The *uterus* weighs rather less than 2 oz., and is 3 in. long, of which the body measures 1½ in., the cervix, 1½ in. The cavity of the body is triangular, with a convexity downward at the base. The cervix has well-marked arbor vitæ. The os is small, and the lips are not everted. The os just admits a large probe. There is a little whitish thick mucus oozing from the os uteri. The mucous membrane is rather thick, and covered with a reddish mucus.

The ovaries are small, cystic, and degenerating. There is a small extravasation of blood in the left ovary.

The measurement of the arms *outstretched* across the chest equals 64 in. The forearm measured 16½ in., the hand, 6½ in. long and 6¾ in. in circumference at the palm.

On the first joint of the dorsal surface of the right little finger is a small round hardening, not amounting to a corn, and a similar but smaller hardening on the inner side of the back of the first joint of the right ring-finger.

The sternal epiphysis of the clavicle had united by bone.

The tissues generally were pale and bloodless.

Comment.—The remains are those of a large, well-nourished woman.

Her *height*, as calculated by the transverse measurements and forearm, about 5 ft. 3⅓ in. The length of the forearm was 16½ in., and this multiplied by $\frac{19}{5}$ equals $62\frac{7}{10}$ in.; the transverse measurement of outstretched arms equals 64 in., so that the mean equals 63⅓.

Her *age* is above twenty-five, as shown by the union of the epiphyses. The presence of a small extravasation of blood in the ovary showed that she had not reached the menopause, but we could not calculate her age more accurately than to say she was over twenty-five and under forty years old.

She had not borne children, as shown by the uterus and absence of lineæ albæ, and the breasts did not give the impression of having been used for suckling.

She was apparently not a virgin, and the vagina had been distended, though not so patent as after child-bearing. The skin is fair and the hair dark brown. The hands are shapely, and the skin soft. There are no marks indicating any occupation, except that on the right little finger is a small circular hardening, but no corn. This mark is such as might be made by writing. There is no mark as of a ring worn on the left ring-finger.

The immediate cause of death was syncope, as shown by the condition of the heart, and the general bloodlessness of the tissues would indicate hemorrhage as the cause of the syncope.

There was *no organic disease* of the viscera examined which would have caused death.

The edges of the cuts showed that *a very sharp knife* had been used; all the cuts had been *made after death.*

All the cuts were made from left to right except those separating the right thigh and right arm, which had been carried from right to left across the flexures of the joints, and so probably done by a right-handed man.

The incisions were evidently made with design, and were skilfully performed, as by a man who had some knowledge of the position of joints and the readiest means of separating limbs—such knowledge as a butcher or slaughterer would possess. They do not indicate a special anatomical knowledge of the human body.

Signs of Death.—The question of the reality of death as distinguished from apparent death is not often raised in these days. There has been, however, among the people of all countries a dread of being buried alive—a fear that has been augmented by sensational reports of exhumations where the position of the body differed so much from that presented when committed to the earth as to cause the belief in the minds of the uninformed that life had not been extinct at time of sepulture. The explanation of this change of posture, as will be seen later, is undoubtedly due in most instances to the effects of the gases arising from decomposition, and not to voluntary muscular movements.

It is possible that in times of severe epidemics of diseases, such as, for instance, cholera or smallpox, there may have been in the desire for speedy interment an occasional case of burial before life was demonstrably extinct, especially in Eastern countries, but such cases are the rare exception. I can recall several cases of persons so imbued with the fear of premature burial that they have insisted, as a last request, upon the opening of a vein or artery after death. One case in particular was that of a very intelligent man, a clergyman and an editorial writer, who was in the greatest state of anxiety upon this subject, and extracted a solemn promise from me that I would not permit the burial to take place till I had opened both veins at the elbow. In consequence of such apprehension, the medical man may be, and doubtless is occasionally, called upon to decide the question of the reality of death. The apparent absence of some of the more commonly known signs of death have a disquieting effect upon the minds of relatives and friends, so that careful consideration of the signs of death, both those presenting themselves immediately at the cessation of life and those which are observed as the consequence of chemical and putrefactive changes at a later period, is most necessary.

It is well recognized that death, whatever may have been the remote cause, begins at one or the other of three points, the brain, the lungs, or the heart, all three being soon involved in the cessation of vital molecular process.

It is only necessary to consider, however, for the purpose of determining the reality of death, the question of the arrest of respiration and circulation. To the onlooker the more obvious of these two things is the cessation of the breathing, which is followed in a short time by the cessation of the circulation in consequence of the stopping of the action of the heart. Usually the breathing is arrested some seconds, or even minutes,

before the cessation of the heart's action, and in any question of doubt the careful examination of the chest should not fail to give evidence, through the stethoscope, of the complete cessation of respiration. The same test should be applied to the action of the heart, inasmuch as it is well known that complete arrest of the respiration need not, and often does not, mean the cessation of life. An example of this is the possibility of the resuscitation of the drowned after a short period of submersion. In these cases often there is no respiration to be detected, though the physical signs of cardiac movements are to be found.

That respiration can be entirely suspended for any considerable period without the consequent cessation of heart action seems incredible, although it has been claimed by some authors that persons who have been submerged in a state of syncope have been resuscitated after as long a period as half an hour, or even an hour. From a physiological standpoint it might be argued that as long as the blood remains fluid, as it generally does in cases of asphyxia, and thus capable of flowing through the heart, that it would be possible, by restoring to the blood the oxygen of which it has been deprived, to furnish to the heart that stimulant which is necessary for its action. It is quite clear, nevertheless, that after rigor mortis is established—and this occurs very soon after submersion, partially owing to the rapid cooling of the body—no such thing as restoring the heart's action would be possible.

While a person who has been submerged in a state of syncope would struggle less, and in consequence of this absence of struggling would inspire a smaller quantity of water, and therefore would be in a somewhat more favorable condition for resuscitation, it is difficult to believe, all things considered, that after the cessation of respiration for so long a period as thirty minutes life would not be extinct; and while, as stated, a few such cases are reported, it is possible that the face was not wholly submerged. At all events, the strongest proof as to the completeness and the duration of submersion should be required before such cases are removed from the domain of the apocryphal.

The condition of the blood at the immediate approach of death from disease, and the rapid change which occurs after the cessation of systemic life, namely, its coagulation, would obviously prevent any possible restoration of the vital processes after the shortest possible period. I would not deny that there are cases where the death appearances have been so striking that even physicians of ordinary skill have been deceived; but I believe had there been a very careful examination of the organs of circulation and respiration, there would have been found evidence that those processes were not wholly arrested, though proceeding in the faintest way.

Two cases which came under my own observation illustrate this position. Some four years ago I was called to examine the body of a young woman who was said to have committed suicide by the self-administration of a solution of carbolic acid. On arriving at the room where the body lay, I found it lying on the bed covered only with a sheet; the eyes were closed, there was no perceptible respiration, and I could not discover any pulsation at the wrist, though it must be admitted that I did not make a very careful examination at the moment, inasmuch as I was informed by the person present that death had occurred more than half an hour previous to my arrival, and I was making inquiries as to the circumstances

of the case. The body was cool but not cold—a condition not one to attract attention at so early a period after death. After a short conversation with the attendant, during which I found that the drug had been taken early in the morning, and, owing to the suicide's having taken the entire contents of a two-ounce vial of the solution, the strength of the solution could not be ascertained, and thereby a conclusion formed as to the actual amount of acid taken, I had occasion to repeat a question in an unusually loud tone at a moment when I chanced to be looking at the body. I noticed a slight movement about the eyelids, and on addressing the assumed dead person by her Christian name, perceived an attempt to raise the lids. Although the physician who was first summoned to the case had some hours before pronounced the woman to be in articulo mortis, and had prognosticated death within a few minutes, I succeeded after a long time in getting animation so far restored that in spite of her objection I administered an antidote, and eventually secured her removal to a hospital, where she recovered without even a sign of gastritis. I am quite sure that had I, in the first place, instead of assuming that death was present, applied my stethoscope to the lungs, I should have found ample evidence that life was not extinct. It is quite probable that the woman might have eventually recovered without medical assistance, as from the subsequent history of the case it is improbable that a large amount of the acid was swallowed; but at all events, she had taken enough to reduce her to a condition where all the more common appearances of systemic life were obscured.

Another case was the following: In the winter months, seven years ago, a young unmarried woman was a patient at the lying-in hospital. When in the month of January she was discharged, from fear of the reception she would meet at home, where her condition had not been known, she strove ineffectually to place the illegitimate child in some one of the public institutions. She then, according to her own statement, reasoning that if the child was found exposed in a public place it would be taken to one of these institutions and its reception there follow as a matter of course, placed the child, with such clothing as was furnished at the hospital, in a basket, and placed it in an alley near a platform erected for the reception of goods into the rear entrance of a store on a principal street. Her idea as to its being immediately found was fallacious, for the child was deposited in the afternoon of Saturday, at a time when there chanced to be no teams sent to this place. The child remained in this alley till the afternoon of the following day, there having meanwhile occurred a severe snowstorm. It was then discovered by a policeman, who, on examination, decided that it was dead, and it was taken to the rooms of a neighboring undertaker, instead of being taken to the morgue, as was the usual custom.

After the body had remained at the rooms of this undertaker for many hours I was called to examine the body. After talking with the undertaker and policeman in another room for a while, the attention of all was attracted by an unusual sound proceeding from the rear room. After an interval of two minutes the sound was repeated, and on investigation it was found that the sound was the very faint cry of the [illegible]osed dead child. There was absolutely no pulse to be found. [illegible]ration occurred at intervals of more than a minute, and auscul-[illegible] showed the faint sound of the heart. Prompt and energetic

measures, covering more than two hours, finally resulted in the complete resuscitation of the child. The babe was then taken to a public institution, and subsequently placed in the charge of the mother, and lived for a period of months, though it eventually died of natural causes.

In this case there can be no doubt that animation was so far suspended and the end of life so near, that had it not been for the chance placing of the child in a warm room instead of the morgue, which then was not warmer than the external air, life would have ceased altogether. It is reasonable to suppose that had an examination of the chest been made at the time of the discovery of the child it would have resulted in the failure to demonstrate respiratory movements, and even the beat of the heart might have escaped notice. Such cases as the foregoing, however, are of the rarest, and if attention is paid to the other signs of death there should be no occasion for doubt as to its actual presence.

There was an additional sign present in the last case mentioned, namely, the coldness of the body, which emphasized the probability of the case being one of real death. This brings us to the consideration of one of the earliest signs of death, namely, change in temperature.

Cooling of the Body.—As is well known, the normal temperature of the living body is 98.4° F., while in many forms of fever, such as typhoid and scarlet fever, the temperature rises to a very considerable degree, sometimes reaching the mark of 113° F. So, too, in cases of septicæmia the temperature will run up very rapidly at the approach of death, and a further rise has been noticed after death has occurred, even when the presence of death has been demonstrated by the unmistakable signs of decomposition, which supervenes with the greatest rapidity after death from this cause.

In ordinary cases of death from disease the loss of the natural temperature of the body takes place with a rapidity proportioned to the surrounding media. If a body remains in a warm room and is covered with clothing, the cooling is somewhat retarded, while if exposed to the air of a cool room, especially if there be a current of air passing through the room, it cools with great rapidity. A body which has remained in water, as after death by drowning, will also cool with great rapidity; on the other hand, the bodies of those who have died suddenly from shock, or from apoplexy, or of acute disease, cool with less rapidity, and as the temperature of the body approaches that of its surrounding media the cooling process is more slow. The experiments of Goodhart, as quoted by Taylor, showed that on the average the rate of cooling for the first three hours was 4° F. per hour; in the next six hours the rate was three degrees per hour; and at a later period, in excess of one degree per hour. The cooling of the body is a less certain sign of death than some others, because it allows of so many variations. As has been already stated, certain forms of disease and accident are followed by a comparatively slow loss of animal heat. Casper has fixed upon the average time of ten to twelve hours for the cooling of the body in ordinary cases, yet in cases of asphyxia, cases of submersion excepted, the cooling is more gradual; cases of asphyxia present great variation, however, some fatal cases being followed by complete cooling in the same time as in cases of death from natural causes, while in others the heat has been known to be retained for as long as forty-eight hours.

In one case of death from septicæmia, where the temperature imme-

diately before death reached 112° F., I found the viscera perceptibly warm at time of autopsy, something more than twenty-four hours after death. On the other hand, the bodies of persons who have died of chronic diseases, and where the death has been slow, cool with great rapidity, not more than four or five hours being required to reduce the temperature to that of a body which had died under other circumstances, and which had required nearly a day to cool. The body in such cases manifests a decided lowering of the temperature, especially that of the extremities, for a considerable time before death. The fact is, that under similar circumstances the dead human body cools practically like any other mass of animal matter. The body of a child will cool more rapidly than of an adult, that of a thin person than that of a fat one, and, as before stated, an exposed body than one invested with wrappings.

Although the time that a body will take to cool may form an important element in a capital trial, the opinion of the medical jurist should be given with a large degree of caution, and with a careful review of all the facts of the case as indicated in the essential particulars enumerated above.

This caution is emphasized by the cases and experiments reported in the works of writers on this subject, notably those of Tidy and Ogston. The former author cites M. Laborde in demonstration of the fact that in five to eight hours the temperature of the deeper tissues falls to 80.6° to 82.4° F., while Dr. F. Niederkorn shows that in six cases taken indifferently the rectal temperature, taken six to eight hours after death, averged 90.6°, and in nine cases where the temperature was taken twelve to fourteen hours after death the rectal temperature was 89.2° F.

The same authors quote the observations of Wilks and A. S. Taylor from *Guy's Hospital Reports*, which show a decidedly lower average of the temperature at corresponding periods after death, the difference being something more than 11° F. for the first period (six to eight hours), and something more than eight degrees for the latter period (twelve hours or more). It is to be observed that the temperatures taken by Drs. Wilks and Taylor were taken by simply applying the bulb to the abdomen, while those of Niederkorn (as stated by Tidy), were taken either in the axilla or rectum.

The chief value of this sign of death, however, lies rather in the continuous and progressive cooling than in any absolute temperature. A case cited by Ogston corresponds with my observation in septicæmic cases. He was called to inspect the body of a seaman who had died suddenly from (as it proved) a sudden effusion of serum into the pleural cavities, while suffering from scorbutus. He found the heat of the trunk and limbs little, if any, below the normal temperature, but on the next day putrefaction had so far advanced as to leave no doubt of the reality of death, the heat being greatest in the chest, where the decomposition was farthest advanced. At another time he was called to see the body of a lad who had died suddenly when apparently in good health and spirits. Perceiving that the lad was dead, he left the house, only to be recalled on the afternoon of the same day because of the belief of the mother that the lad was about to come to life again, inasmuch as the body did not become cold, there was no rigidity, and the color had returned to the cheeks. Dr. Ogston assured her that these phenomena were only those of rapidly approaching decomposition, which was fully developed on the next day.

This return of color to the cheeks has been frequently observed in the bodies of those who, for the purpose of preservation, have been frozen by the undertaker and on the day of sepulture removed from the freezing mixture a few hours before the funeral rites. The return of a flush of color closely resembling the natural hue of life ensues and endures for a few hours, when it passes with great rapidity into the dusky hue of decomposition. That there should be a rise of temperature to something like that of the surrounding atmosphere is of course natural, but it is claimed that it may rise, in consequence of this putrefactive change, even higher than that. From the facts stated above it will be seen that the caution to be observed by the medical expert in giving an opinion as to the time which has elapsed since death occurred should be, as before stated, very considerable.

Changes in the Eye.—Immediately after death the eye loses its luster in the great majority of cases, and, in addition to this loss of luster, the cornea becomes opaque, milky, and sensibly flattened, the globe having lost its normal tension, and, of course, there is no response to light by the pupil. I have said that this condition of the eye obtains in the majority of cases, but in cases of death by carbonic acid and carbonic oxide, cyanide of potash and hydrocyanic acid, I have seen this change in the eyeball wholly wanting, or very long delayed.

At this very writing I was called to view the body of a man who had in a fit of melancholia taken an indefinite quantity of cyanide of potash in a public square and died within twenty minutes. Directly after death, and again two hours later, the eyeballs were prominent, staring, glistening, with the pupils widely dilated, and eighteen hours after death the same condition was present.

There is also at the time of death a change in the color of the body, which, with very few exceptions, such as in the cases of people with very florid complexions, becomes an ashy white. The exceptions above mentioned rest on the statement of Casper. I have never seen exceptions to the rapid pallor in cases of death, except in cases of death from burning and some cases of suffocation. But while certain colors will disappear, such as the redness of scarlet fever, on the other hand the yellow of jaundice, the purple of ecchymosis, and the varied colors of tattooing remain.

There is also at the time of death, or immediately thereafter, a general relaxation of the muscular system—the lower jaw drops, the joints are flexible, and the eyelids lose their tension; but although the tonicity of the muscles is lost, it is not the case with their contractility, inasmuch as they will respond for a certain time to electrical and other stimuli, and moreover muscles that are contracted by living force at the time of death, as in the case of poisoning by strychnine, do not necessarily become relaxed in death.

According to Ogston, the persistence after death of the muscular contractibility in different parts of the body and its disappearance follows a fixed order, the first parts to present this change being the neck and trunk, next the lower extremities, and lastly the upper, while its departure follows the same order.

The duration of this phenomenon is shortened by its exposure to warmth and moisture, and to ammoniacal, carbonic, and sulphureted hydrogen gases; it is unaffected by carbureted hydrogen, hydrogen, and

sulphurous acid gases, nor is it diminished in cases of asphyxia. It has been found, however, that the continuance of this property of muscular fiber is considerably modified by the nature of the disease of which the person died. Experiments show that it disappeared from the muscles in cases of peritonitis in three hours; in phthisis, schirrus, and cancer, in three to six hours; in death from mortal lesions of the heart or profuse hemorrhage, in about nine hours; in apoplexy with paralysis, in about twelve hours; and in adynamic fevers and pneumonia, in from ten to fifteen hours. (Ogston, Lecture XXV.)

So far as the signs of death which have thus far been mentioned (namely, the cessation of respiration and circulation, the loss of the luster of the eye, the pallor of the surface, the relaxation of the muscles, the loss of animal heat, and the loss of muscular contractility) indicate the period of death, it is practically agreed by all writers on this subject that a body in which all these phenomena have occurred has been dead for a period of from ten to twelve hours at the longest, provided there are no other changes to be noticed.

Succeeding the changes just mentioned, and preceding the commencement of decomposition, are certain other changes originating in the physical alteration in the soft solids.

Softening or want of elasticity of the tissues of the body, which comes in evidence soon after death, is the first of the changes resulting from the destruction of their physical properties. The parts of the body on which it rests will be flattened, and the skin will present the marks of any peculiar figure upon which it has been lying, as for instance the grating of a dissecting-table, and the skin and muscles do not resume their original condition upon the removal of the pressure which, either by the weight of the body itself or from external sources, has been applied to the parts which show this loss of elasticity. This flattening of the dependent parts has been considered a valuable indication of the reality of death.

Rigor Mortis.—At the disappearance, or often a little before the disappearance, of the softening just described, comes another sign, that is, the appearance of an opposite state of the limbs and joints, which is known as cadaveric rigidity, or rigor mortis. The body becomes rigid, and is incapable of contraction. The muscles acquire a brawny firmness, and it requires considerable force to move the joints from the position which they have assumed. This phenomenon is not an active process, but the limbs become, as it were, fixed in the position which they had when this change occurred. This cadaveric rigidity affects not alone the external muscles, such as those of the jaw and limbs, but also is to be demonstrated in the internal organs, especially in the left ventricle of the heart. The duration of this state is variable. It usually disappears with the approach of putrefaction, but I have seen it present after the abdomen has assumed the greenish color characteristic of that condition. The portions of the body to be consecutively affected by this change follow practically the same order as that mentioned in regard to muscular contractibility. It is first noticed in the lower jaw, where it is always most pronounced, and where the greatest force is required to overcome its effects, and where it persists the longest, according to my own experience, though I am aware that this observation does not coincide with the observations of some other writers. It next appears in the neck and

trunk, then in the lower extremities, and lastly in the upper extremities. When it is once gone it does not return, but gives place to a softening of a kind different from that previously mentioned, which is not only more marked, but proceeds to complete putrescence.

The early appearance of cadaveric rigidity is modified to a certain degree by the causes operating immediately before death. Under the action of strychnine and those alkaloids which cause death by convulsions, the more violent and frequent the convulsions the sooner the rigidity sets in. It seems to be accelerated by whatever exhausts the muscular irritability before death. In cases of death from exhaustion or from septicæmia it has been observed that rigidity sets in early and passes away quickly, and is very speedily followed by putrefaction.

While the time of its appearance varies considerably in different cases, in some being noticed as early as eight to ten hours after death, and in others being delayed for more than thirty hours, and while in some cases its coming and going is so speedy as to leave a doubt whether it occurred at all, as in death from lightning, it is fair to state that the mean time of its occurrence is from ten to twelve hours.

Two cases illustrative of this long duration of post-mortem rigidity are these. A man died suddenly of organic disease of the heart in late September. On the exhumation of the body eight weeks later there was marked rigidity of the lower extremities—so marked that the body could be carried from one room to another by power applied to shoulders and feet only. The rigidity had, however, wholly disappeared from the arms, but was present in the lower jaw.

The arm of a mutilated body was recovered from a river in which the arm had lain long enough to have the skin of the hand quite macerated, and after its removal was kept without preservatives for a period of at least two days before being examined by the deputy-coroner of the district. At time of examination the death rigidity was very pronounced in the elbow-joint. A case like this must be considered as quite exceptional. It is also to be borne in mind, in regard to the former case, that the loss of rigidity noticed in the arms while it was present elsewhere may have been due to the forcible flexing of the joints in dressing the corpse shortly before burial.

The duration of the rigidity is also subject to considerable variation. Generally it lasts from twenty-four to thirty-six hours, while it has been known to last for several days. Cold favors the continuance of this condition, as does also previous vigorous constitution, and in cases of death from accident or violence its duration is prolonged. Its duration is less in the young and those in advanced life. It is said, as before mentioned, that in cases of death from lightning the rigidity is but little marked. I have seen but one case of death from lightning, and though the deceased was a child of but five years, the rigidity, though not strongly marked, was still undoubted.

Various explanations of this condition of rigidity have been offered by physiologists and writers on legal medicine—such, for instance, as the coagulation of a proteid in the muscle-plasma giving rise to the so-called myosine—but though its seat is undoubtedly the muscular system, it cannot be said that any of the theories advanced are wholly satisfactory. The importance of bearing in mind the fact that this condition affects internal organs is demonstrated by the mistakes not infrequently made

of attributing certain appearances, such as a seeming thickening of the left ventricle, to pathological change during life, when the appearance was wholly due to the presence of post-mortem rigidity.

Casper states that after death from narcotic poisoning this rigidity either does not occur, or is of so short duration that at the usual time when such bodies are received by the medical jurist for observation no trace of it is found. This does not correspond with my observation. Indeed, within the last sixty days I have had opportunity to examine the bodies of two persons, both cases of suicide by laudanum, where the rigor mortis was quite pronounced at the time of autopsy, more than twenty-four hours after death. I find that my observations in this respect are in accord with those of Tidy.

When a joint stiff from rigor mortis is forcibly bent, the stiffness does not return, and this may distinguish real death from certain cases of supposed trance, from cases of catalepsy, and from the rigidity of tetanus or poisoning by strychnine, and some other poisons.

There are several so-called tests of minor importance which should be mentioned here, although if the signs already mentioned are present there should be no doubt as to the reality of death, inasmuch as the tests themselves are rather tests of the cessation of the circulation than of anything more. The first of these tests is to note whether, after making an incision in the body, blood flows, especially if it flows in jets instead of a continuous dribbling. A dead body does not bleed in the ordinary sense of the word. It is said that bright steel needles inserted anywhere in the skin will be found free from rust even after some hours; but as this test depends on the condition of the body as to cooling and moisture, it is not trustworthy. Another test is the attempt to produce vesication by heat or blistering fluids, it being assumed that as the formation of a blister is a vital process, it could not occur after death; yet as a matter of fact it has been found possible to produce a certain kind of blister upon the skins of young persons shortly after death. Another test is the observation of the translucency of the fingers and hands. If the hand of a living person, especially if young and in good health, be held in front of a bright light with the fingers closely approximated, there will be observed a pinkish red, almost translucent appearance, while after death the hands become opaque. Yet in demonstrating this test to a class of students, the subject being a girl in whom the unmistakable signs of death were present, I found that the hand was still translucent, and that the pinkish color at the edge of the approximated fingers was quite demonstrable. This case, however, is very exceptional. Another test is the production of local congestion by obstructing the flow of the current of blood, as, for instance, by tying a string around the finger. The usual phenomena of swelling and purple discoloration will not follow this constriction in the dead body.

Ogston calls attention to a form of cadaveric rigidity which I believe to occur, though I have never chanced to see an instance. It is what is called cadaveric spasm. It consists in a sort of spasmodic contraction which is assumed by the muscles at the instant of or immediately before death, and which is retained for some hours after death, then passing into true rigor mortis. It has usually been observed in forms of sudden or violent death, but it has also been known to occur after death by pneumonia and pulmonary apoplexy. Ogston, in addition to mentioning

eleven cases which came under his observation, cites a striking example of this kind of rigidity which occurred at the battle of Balaklava. Captain Nolan, while riding in the advance of the cavalry, had his chest torn open by a shell from the Russian battery. The arm which he was waving in the air at the time remained uplifted, and he retained his seat upon his horse, which wheeled round and retreated; the rider gave a death-shriek, and passed through the ranks in the same attitude before dropping from the saddle.

Inasmuch as the hand of a dead person cannot be made to grasp a weapon, it is of importance to bear the possibility of this kind of spasm in mind, as suicide would be indicated where the weapon was found grasped in the hands of a corpse. On the other hand, the finding of clothing, or fragments thereof, or hairs grasped in the hand after death may form an important part of a trial for murder. It is to be noted in this connection that after death from strychnine, as mentioned before, the rigidity, if forcibly broken down, returns after a time, while in other forms of tetanic spasm it is believed to disappear shortly after death. I have observed this return of rigidity after forcible flexion in the case of a man who had partaken of some cheese which had been plentifully covered with strychnine for the purpose of poisoning rats, and who had died from asphyxia from the spasmodic fixing of the muscles concerned in respiration. But in the case of a middle-aged woman who had prepared a fatal dose for her husband and had by mistake taken it herself, and who died from exhaustion, this phenomenon was not to be produced. Indeed, the former case was the only one of many cases of strychnine poisoning in which I have noticed a return of rigidity when it was once broken down after death.

As an indication of the period at which death has occurred, the presence of rigor mortis, in addition to the signs previously mentioned, and without other signs to be mentioned hereafter, the presumption is, according to Casper, that the person has been dead within from two to three days at the longest.

Soon after death, sometimes within an hour, and generally within twelve hours, there are to be noticed upon the exterior of the body certain changes in color due to the gravitation of the blood in the capillaries. These lividities are usually found upon the under or dependent portions of the body. If the body has chanced to remain upon the face and abdomen, it is upon those surfaces that the color changes are found. The color varies from a light pinkish tinge to a deep purple, and not infrequently these purple discolorations are mistaken by the inexperienced, especially by friends and relatives of the deceased, for marks of violence inflicted during life. If the body has rested upon the back, the lividities will be found there, except at the points where the pressure caused by the weight of the body has been greatest. Here the skin will have its usual pallor.

There is an appearance similar to this which I have observed in the cases of the drowned which have been exposed to extreme cold immediately before and after death. I had occasion to examine the bodies of four sailors who were wrecked off a ledge at the entrance to Boston Harbor. The cold and the action of the waves dashing the bodies against the shore had so flattened them they bore a grotesque resemblance to the cakes in a pastry-cook's shop made and baked in the form

of a human being. All these bodies were of a rosy pink color over their entire surface. This was probably nothing more than a frost erythema, but it was very much more marked than I have observed in the cases of those who were frozen in squalid rooms on land.

Again, I have noticed the same appearance in the bodies of those who have died of poisoning by illuminating-gas, especially in those who have inspired the mixed form of gas which contains a large proportion of so-called water-gas, where the percentage of carbonic oxide is very high. In these cases there was not only the bright scarlet color of the blood and muscles and internal organs, but a decided pinkish tint to be seen all over the surface. This color in the cases of those poisoned by this gas is much modified, and in some cases largely wanting, if the patient has received very energetic treatment before death, especially if the person has had a large amount of pure oxygen administered. There need be no necessity for confounding these conditions of color if attention is paid to the location of the change. The post-mortem hypostases are to be found in the dependent parts chiefly, while frost and carbonic oxide affects the color of the whole surface, the superior quite as strongly as the inferior.

Hypostases are easily differentiated from ecchymoses, or bruises inflicted during life, by comparing the results of an incision in the discolored parts. No cut in a post-mortem lividity will ever give vent to fluid or coagulated blood; there will be at most a few reddish points; while an incision into an ecchymosis discloses immediately the true blood effused into the tissues.

There is a wide difference of opinion as to the value of these hypostases as an indication of the reality of death. Casper puts it tersely: "They are of themselves a sufficient indication of death." Ogston, on the other hand, maintains that, while of importance, they are not much to be trusted as indications of the reality of death, on account of their liability to be confounded with marks produced before death. He claims that the term "hypostases" is incorrect, as they occur not alone on the dependent but on the non-dependent portions of the body as well; nor are they to be termed cadaveric, as they may be observed in certain instances upon the living. My own experience leads me to doubt if they are ever found to the extent upon the living which they are upon the dead. They generally are to be seen covering the larger portion of the dependent parts, the exceptions being, as before stated, where certain portions have been subjected to pressure, and even here they may be noticed after a time if the pressure be removed. Neither have I observed on the non-dependent portions of the body any considerable patches which in character and size could be considered as lividities from settling of the blood. Even where small patches of this sort are to be found on the limbs of the aged, and in typhus and other adynamic diseases, it is a question if they do not indicate a possible putrefactive change locally. Believing as I do that this settling of the blood is the immediate precursor if not the initial process of decomposition, it seems to me that the presence of these lividities is a very strong indication of the reality of death. It may be well to wait for a little while to observe the extent of the lividities, for often at the outset of the process they are in irregular patches small in extent; but after a few hours it would seem impossible for a careful observer to confound these with the result of a vital

process, such, for instance, as the effects of flogging, where there would be presented on incision the appearances characteristic of ecchymoses.

These hypostases occur not only externally, but also in the internal organs, especially in the brain, the lungs, the kidneys, the intestines, and the spinal cord.

In the brain the condition is noted by an overloading of the posterior portion, marked by a fullness of the veins of the pia mater, and is to be found even in cases of anæmia or hemorrhage. This is to be observed chiefly where the body rests, as is usually the case, upon the back. Experiments have shown that where this change does not take place soon after death it is quite doubtful if it can be artificially produced. Care should be used to avoid confounding this condition of the veins of the posterior hemisphere with the pathological condition of cerebral hyperæmia, which is more general in location rather than restricted to the posterior portion.

In the lungs these hypostases occur oftenest. They manifest themselves at a much earlier period than is usually stated; indeed, in the old and feeble there is a process very like it during life, owing to the extreme feebleness of the circulation; but after death, inasmuch as the lungs generally have a large amount of blood in their vessels, this fluid gravitates with considerable rapidity. An incision into the posterior portion of these organs, if the body has rested on the back, shows marked overloading even in a lung otherwise generally anæmic. This condition is very readily confounded with an ante-mortem congestion, especially as there is often more or less œdema present at the same time.

In the intestines the line of demarcation of the portions colored by settling of the blood is quite pronounced, whereas in a case of inflammation the color would not only be brighter and show the ramiform injection of the blood-vessels typical of that process, but would also be continuous. The color of an inflammatory process in the kidneys, for instance, would be continuous, while in the simple condition of post-mortem change in the intestines, if the convolutions be pulled forward, the breaks in color which distinguish hypostases from inflammatory process are readily distinguishable. The same remarks which have been made in regard to post-mortem congestion of the posterior hemispheres apply to the hypostases of the spinal cord, and great care should be exercised by the medical expert that he may not confound what is merely a cadaveric change with what he might suppose to be a vital inflammatory process.

In this connection it is well to mention that while the heart does not present hypostases, certain changes take place in the contents of the cavities, namely, the coagulation of the blood and the formation of either red or white clots, the so-called cardiac polypi. These clots are sometimes formed, in a case of slow death, before life is extinct; but usually they are formed after death, during the cooling of the body. Moreover, the ante-mortem clots are more difficult of removal, because they are mixed up with the chordæ tendineæ, etc., while the post-mortem clots are loose, and simply assume the shape of the cavities. The establishment of the fact of the coagulation of the blood after death has a bearing upon the question of the formation of ecchymoses. It was formerly held that the presence of an ecchymosis upon a dead body was evidence that the violence which caused it must have been inflicted during life; but now it is

known that violence inflicted upon a body after life is extinct, but before it has cooled, may present the same appearances as it would if the injury were done during life. Although generally the blood remains fluid for a considerable period after death from suffocation and from drowning and from other forms of asphyxia, I have found it in many cases coagulated even in the right auricle.

Putrefaction.—The last change which takes place in the body after death begins with the occurrence of putrefaction, where chemical changes take place in the human body as in any other kind of dead animal matter, and where offensive gases are evolved. After a longer or shorter time the whole organic mass is changed to inorganic matter, chiefly water, ammonia, and carbonic acid, and in the transition stage compounds of nitrogen, sulphur, carbon, and hydrogen are evolved.

Generally speaking, this change succeeds upon the disappearance of cadaveric rigidity; but, as said before, I have observed cases where the putrefactive process was demonstrated by the discoloration of the lower portion of the abdomen, while the death rigidity had not wholly passed away.

There is some variation as to the region of the body primarily affected by putrefaction. In cases of drowning, as will be seen later when discussing that mode of death, it generally manifests itself first upon the head, neck, and upper portions of the body; in other cases it usually is first noticed as a green or greenish-yellow discoloration of the abdomen, accompanied by great tumidity thereof, and of the scrotum, penis and labia. Subsequently this discoloration is to be observed upon the face and neck, and lastly upon the legs and arms. A somewhat striking instance of the manner in which the loose connective tissues are affected by this process of decomposition was observed by me in the early part of the present year. The body of a person who had been in the water, as was afterward proved, several weeks was presented for inspection. On the afternoon of the day when the body was first observed there was noted the marked advance of decomposition about the head and neck, while the rest of the body was quite free from the appearances caused by putrefaction. The retraction of the penis commonly observed in cases of drowning was noted. On the following day, as the body was uncovered for purpose of autopsy, it was noted that the penis had assumed a position of semi-erection, and was of nearly the same size as it would have shown in erection during life. Of course, here the change was wholly due to the action of the gases of decomposition. Ogston states that the discoloration of putrefaction usually commences at the center of the belly and extends toward the groins. I doubt if any general rule can be laid down as to this order. My own experience has been just the reverse. The greenish color has manifested itself at the groins first, and thence extended to other regions. As Ogston was a careful observer with large opportunities, I believe that it is safest to assume that it may begin anywhere on the abdomen, with no regular order of procedure.

In certain forms of death the evidence of beginning putrefaction will be found in other regions than the abdomen. Take, for instance, cases of death from septicæmia. There I believe it to be the rule that unless there is some special means used to retard putrefaction, decomposition will be first evidenced by the purple color of the superficial veins, which

will be quite distinctly mapped out on the surface of the arms, neck, and shoulders. Some stress has been laid upon the order of the appearance of these signs of putrefaction as a test for discriminating bodies which have begun to decay in the water from those which began to decay in the air or earth. Casper and Devergie hold this opinion, and it accords with most of the observations made by me; and when we consider what especially favors decomposition, there seems good ground for believing that the bodies of the drowned should show the marks of putrefaction most strongly, as well as earliest, in the upper regions of the body, inasmuch as the things that chiefly favor decomposition are moisture and heat; and as we shall see when treating of death from drowning, in that form of death usually the head, chest, and upper part of the body are much overloaded with blood. But I have noted one case which coincides with Ogston's experience, having met the green discoloration of the body in a case of death by drowning before it appeared on the chest.

I had occasion some ten years ago to examine the body of an elderly man who was found in the water just within reach of high tide, in Boston Harbor. The man had been missing but a short time, less than thirty hours, before the discovery of the body. The clothing was thoroughly wet, and the usual appearances of a body which had lain in the water, such as corrugation of the skin of the hands, etc., were observed. There were many things in the history of the man's recent past which would warrant an opinion of death from suicide, and that the method was submersion; but there was no sign of putrefaction about the head or chest. A moderate amount of rigor was present in the lower limbs, and the lower region of the abdomen from the groins nearly to the umbilicus was of a green color. The section of the body, however, showed clearly the presence of water in the lungs and stomach, a moderate congestion of the solid viscera, and an overloading of the right side of the heart, and no other cause of death. Undoubtedly the appearances in this case were modified by the fact that the man was feeble and had simply lain down in shallow water, and had died from asphyxia without making any struggle.

The pressure of the gases evolved in putrefaction is very considerable, and is not only sufficient to account for the escape of the contents of the alimentary canal, but for more pronounced phenomena, such as the bursting of the coffin after inhumation, and for changes of position in the dead, which have been attributed to the terrible struggles of the prematurely interred. I observed during the intensely hot summer of 1887 a striking instance in point. The body was that of a very large and fat woman, who was a laundress. She lived and worked alone in an upper room of a house in the crowded part of the city, where she was exposed to all the intensity of the summer heat in addition to that of her own stove, heated for the purpose of her occupation. Her absence was not noticed till the second day, as she had no family. The thermometer had registered for those forty-eight hours from 85° F. to 92° F. When the body was found, it was swollen to a third more than its natural size. The tongue was black and protruding from the mouth, and the large intestine was inverted like a glove and protruding for nearly two feet of its length from the anus, while the whole of the exposed parts of the body were covered by thousands of larvæ.

The effect of these same gases is also to be observed in the flow of blood from the wounds made on the bodies of the drowned by the ravages

of marine animals. From the effects of these putrid gases upon the face, there may be such a change in the features as to render an identification of the body by the physiognomy a difficult if not an impossible matter. The decomposition of the upper regions of the bodies of the drowned, after removal from the water and exposure to the air, proceeds with the greatest rapidity. Features which were quite distinct at the time of the recovery of the body may become quite unrecognizable after the lapse of twenty-four hours in the summer.

There is also a change in the color first observed as a sign of decomposition. The red of the superficial veins will change to a brownish black, and the green color of the abdomen and other parts of the body changes to a brown and even to a black.

Simultaneously with the changes produced externally by putrefaction are changes in the appearances of the viscera. The mucosa of the larynx and the bowels present discolorations which might be mistaken for the signs of poison or disease. The mucous membrane of the stomach presents various tints: a reddish brown, a livid purple, or, more commonly, if observed a considerable time after death, a slate color. This slate color is particularly noticeable in the brain where the bodies are examined within a week or ten days after death, provided no means have been used to retard decomposition.

It is by no means easy for the medical jurist always to distinguish between the effects of poison and the effects of decomposition by mere inspection. In both cases there will be redness, and this more or less circumscribed; and an additional element of doubt is presented when the possibility of the action of the digestive fluids themselves is considered. Taylor lays down the rule that the change has taken place during life if it is met in an examination soon after death; yet I have seen many cases where the stomach presented a redness suspiciously like that caused by irritant poison, when death had occurred from natural causes soon after the ingestion of food. When the redness is accompanied by effusion of coagulated blood, mucus, or the effects of ulceration, corrosion, or destruction of the coats of the stomach, we may assume that it was the result of a vital process. In such cases, if there be doubt, the well-known effects of irritant poisons upon other organs, notably the liver and kidneys, should help the solution of the problem, and at all events a properly made chemical analysis of the viscera should absolutely determine the question. A delay in expressing an opinion till the facts are definitely ascertained can do no possible harm, while the opposite course might involve the physician in an awkward dilemma at a later period.

Another point, which will be of service in the differential diagnosis of irritant poisoning during life, and the reddening of the mucous membrane of the stomach after death, is that this redness will be observed in all the other viscera as well. It is especially noticeable in the membranes which naturally have no color. The deep staining of the aorta and of the respiratory canals is an instance in point. It is true, however, that Trouseau and Roget succeeded in producing the appearances of true inflammation upon the bodies of the dead, so far as these appearances consisted in the injection of the vessels rather than the general dyeing of the parts.

As a consequence of the progress of putrefaction the blood becomes fluid, and the action of the gases may change its position to the extent

that it may be forced from the cavities of the heart, where it was in large quantity at the time of death. It is propelled toward the capillaries, and gives to the external portions of the bodies, seen some weeks after death, a diffuse redness differing from the early post-mortem discoloration; and this redness is accompanied by a looseness of the cuticle, which presents a sort of blistered appearance. Moreover, this discoloration affects the true skin, and the subcutaneous areolar tissue is bathed in reddish serum, and the back part of the scalp presents an appearance appropriately compared by Ogston to red-currant jelly.

In the cases which I have observed I have found that the suggestions made by Ogston are of much value: namely, that, first, in post-mortem redness the color is limited to the course of the vessels, while in inflammatory redness the parts around the vessels partake more or less of the coloration; and second, that in inflammatory redness the color is usually limited to the inflamed membrane, while in the redness from putrefaction the color pervades the whole of the tissues of the part.

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The rapidity with which decomposition occurs varies considerably, according to several factors which may obtain. It is favored by high temperature, by moisture, as exemplified in the cases of the dropsical and the decay of the upper portions of the bodies of the drowned, by free access of air, absence of clothing, previous injuries, sudden death, acute diseases, especially those of a septic character, corpulence, and possibly by the cause of death having been poisonous gases or animal poisons. Whether prussic acid favors rapid decomposition, as claimed by some authors, or not, I cannot say further than that in the few cases which have come under my personal observation there was no perceptible increase in the rapidity of decomposition within the first three days, as compared with that of cases of death from other causes.

On the other hand, decomposition will be retarded by low temperature, or very high temperature where the body has been thoroughly cooked and charred. Also profuse hemorrhages, which diminish the amount of fluid in the body, tend to retard decomposition. Continued immersion in water and burial in a deep grave, by keeping the body at a low temperature, also retard putrefaction, though the process of decomposition goes on with the greatest rapidity after the body has been removed from such surroundings. Burial soon after death, and burial in dry sand or earth and in dry, elevated ground, is said to retard decomposition. This does not correspond with my observations in a few cases of exhumation, neither does the claim that nitrogen gas and the residuum of air in air-tight coffins retard decomposition. Certain poisons, especially arsenic and alcohol, are claimed to render the body less liable to rapid putrefaction. I have found that the cases of death from acute and chronic alcoholic poisoning differ in rapidity of decomposition very little from those of death from other causes; if there has been a difference, it is that the bodies seem to decay with rather greater rapidity than the bodies of those where death has resulted from various natural causes, which seems only reasonable when the changes produced in the body by alcoholic narcosis are considered.

I may say, in this connection, that the most rapid and repulsive condition of putrefaction which I have seen, a case where the body was largely liquefied, was that of a man who had died of arsenic poisoning, where the drug had been administered in pretty large doses for a period of several days, and where the body had been buried in dry, elevated soil in

a nominally air-tight casket, and afterward exhumed and transported two days before examination. Of course, leanness—and old age, which favors leanness—(aside from dropsical conditions or corpulence), favors slow putrefaction by the absence of an excess of those fluids which naturally hasten this process. Since writing the above I have had occasion to examine the body of a man exhumed after a burial of eight weeks. The cause of death was organic disease of the heart. This body was, in general, in a very good state of preservation. Chiefest to be noted were the large spots of mold upon the cheeks and chin and forehead, while the orbits were filled with a white fluffy mold presenting quite a contrast to the greenish tinge of the mold elsewhere. There were some vesicles as large as an English walnut upon the flanks, purplish in color and full of serum, but slightly tinged. The brain was quite soft, but preserved its form and permitted of sections with a thin, very sharp knife, and the different structures, as, for instance, the corpora striata, were in condition to be fully examined. The heart, as would be expected of an organ which resists decay among the longest, admitted of clear discrimination between the effects of post-mortem change and the fatty infiltration which had occurred during life. The scalp was mummified, rendering its removal rather more difficult than usual; but all the organs were in a better state of preservation than I have seen, twenty-four hours after death, in many cases of septicæmia, where the body had been kept in a moderately cool room.

Various forms of so-called embalming are supposed to prevent putrefactive changes. I have never had occasion to witness the condition of a body at any long period after the injection of the cavities or the arteries with the various so-called preservatives, but in many cases I have noticed that putrefaction proceeded with unusual rapidity after this process, while in none have I seen any difference in the putrefactive change between the embalmed and non-embalmed during the usual period elapsing between death and burial. Of course, much may depend upon the kind of fluid and the skill of the operator; but as far as my own experience goes, this process of embalming tends rather to the obscuring of signs of death from poisoning, and the pecuniary advantage of the undertaker, than to anything else.

Any consideration of the subject of putrefaction would be incomplete without allusion to a change which occasionally occurs at a long period after death, namely, the saponification of the body, or the formation of adipocere. This change is wholly chemical, and consists in the union of the fatty acids with ammonia. It has been oftenest observed in bodies that have lain a long time in water or in very damp soil, where moisture has continuously acted upon a putrefying corpse. There are some other conditions under which adipocere is formed, but the two mentioned are the only ones definitely known. Its formation to any considerable extent usually requires a long time, though it may begin to form at a rather early period. Casper cites the case of one child where adipocere was observed after the interval of only three weeks, and of another child where it was noted after a period of only thirteen weeks; but usually a period of three to four months in the water, or of six months in moist earth, is required before this saponification occurs. It is not necessary that so long a period as many years should elapse before it is formed, as was at one time supposed.

Adipocere is a fatty substance, generally of a yellow color, occasionally of a pure white. It is unctuous or soapy, brittle, and soft to cut. It melts at different degrees of temperature, some requiring no more than 200° F. As it is due to the checking of the colliquative putrefaction, it occurs more readily in the bodies of fat people than in the lean, and children present the change more readily than do adults. In addition to the value of this condition as an indication of the length of time that has elapsed since death, it is of importance to bear in mind a fact to which Günts has called attention, namely, that adipocere is always greater in volume than the total amount of fat preëxisting in the body, and therefore in weighing the body of a new-born child for the purpose of ascertaining the age allowance must be made for the difference.

This saponification of the body has also been termed mummification, but as true mummification is essentially different from the chemical process by which adipocere is formed, the terms should not be used as if interchangeable.

True mummification consists in the rapid evaporation of the watery constituents of the body. This change is favored by very high temperatures with great dryness of the atmosphere, and by atmospheric draught. In this dried state the soft parts are retained, and the features, though distorted, are preserved, and present a rusty brown color. The internal organs have partly disappeared, or are blended together so as not to be distinguished from one another, and they present an odor more like cheese than that of a putrefying body.

Whether occupation has any effect on the process is not known, in spite of the assertion of the First Clown in "Hamlet," that "a tanner will last you nine year." It must be admitted that his assertion that "your water is a sore decayer of your whoreson dead body" is confirmed by medico-legal observation.

At all events, the value of the process of mummification to the medical jurist is, as Casper says, practically confined to the question of the mummification of the umbilical cord in the new-born and the mummification occurring in bodies after arsenic poisoning.

Chronological Order.—Though it doubtless is true that the medical jurist should never refuse to perform an autopsy, irrespective of the time that has elapsed after death, it is well to consider what the relative order of change is, in order that the probability of obtaining any satisfactory data, either as to the cause of death or any other ante-mortem conditions, may be properly estimated. It is well known that certain organs resist decay much longer than others; and in a body where there would be no possibility of determining whether the cause of death may have been natural, like typhoid-fever, or a poison, like hydrocyanic acid, it might still be possible to determine the sex by the discovery of a uterus or a prostate gland, or to determine the question of pregnancy in the female. Even in the bodies of those dead for a number of years, though pathological changes are no longer to be perceived, yet the remains may afford proof of the presence of some of the mineral poisons in the débris.

Therefore the chronological order of the phenomena of putrefaction in the internal organs deserves especial attention. There is practically little difference among authors as to this order. First to present the changes of putrefaction are the trachea and larynx. Whether due to the access of atmospheric air or to imbibition, it is certain that in from

three to five days in summer, and six to eight in winter, the trachea assumes in its mucosa a uniform dirty cherry-red or brownish-red discoloration without vascular injection. This color is to be differentiated from that bright color which obtains in cases of death from asphyxia or from laryngitis. But in these cases both the history of the case and the period after death at which the examination is made will help to determine the question. As putrefaction goes on the mucous membrane becomes olive-green and the cartilages separate from one another, but months elapse before they disappear.

Next in order come the brains of new-born children and those under one year of age. The contents of the cranium of these children are very soft, the access of air is easy, and they are not affected by those changes in consequence of modes of life which sometimes render the brains of adults more durable, as in the case of extensive supplanting of cerebral matter with connective tissue granulations, and their subsequent contraction, which is so often observed in the brains of chronic alcoholic subjects.

The stomach putrefies at a very early period, generally in five to six days, the traces of the change being observed in a dirty red color at the fundus, and this color is at first noted in isolated patches and on the posterior wall, rapidly appearing afterward on the anterior, and then fading into a dirty gray with patches of black, while later the coats become softened. Next in order of putrefaction are the intestines, and the changes occurring there are similar to those which have been mentioned as happening in the stomach. The change caused by bile-staining has already been mentioned. The intestines eventually burst and discharge their contents, and finally become a pultaceous mass.

The spleen is said to resist decay longer than the organs just mentioned, but it is certain that it softens very quickly, and especially in cases of septicæmia. It softens with the greatest rapidity, and may become almost liquefied in some cases, while in others it assumes a steel-gray color with rather more consistency.

If fairly free from fat, the mesentery and omentum resist putrefaction for a period of several weeks, but the process is somewhat accelerated if they are very fat.

In new-born children the liver begins to putrefy earlier than the liver of an adult, which may be found pretty well preserved several weeks after death. I have seen it in a fair state of preservation at a period six weeks after death. The convexity shows the greenish change first, which eventually pervades the whole organ, and as time passes the organ becomes more and more pultaceous. The gall-bladder remains for a much longer time recognizable.

The brain of an adult shows the change of putrefaction first at the base, and a greenish color pervades the whole organ; but the color is not so pronounced as elsewhere, at all events at the earlier stages. The color is more of an ashy gray, and the brain retains this color even after it has become very soft, even to the point of almost liquefaction. I have never observed, as a result of putrefaction, the reddish pulpy condition which is to be observed at a very early period in the brain of the new-born, although that such a condition may be found cannot be doubted, as it has been observed by many writers on the subject. The brains which have been seen by me when they had arrived at a condition of putrefaction have been cases examined, at the farthest, three months

after death. These were uniformly gray and soft, some even to liquefaction; and I admit that it does not seem clear to me where these particular brains were to get the tinge of red at any subsequent period, which Casper says putrefying brains do months after death.

The heart and lungs begin to putrefy at pretty nearly the same time. The heart will be found empty of blood and somewhat shriveled, the pericardial fluid will have evaporated, but still the heart muscle will be clearly recognizable, and, in general, permitting, months after death, and long after the other organs mentioned have passed beyond recognition, a pretty good idea to be formed as to any pathological change. The same is true, in a measure, of the lungs. The structure may be demonstrable, and a differentiation between gray hepatization and putrefactive change may be possible many weeks after death. The diaphragm is a muscular structure like the heart, capable of resisting decay for a long time; but the organ which presents the greatest resistance to putrefactive change is the uterus. This will be found intact after the destruction of the external genitals. Casper cites a case of an adult whose body was in a very advanced state of putrefaction, and which had lain in a privy vault, a condition favoring rapid decomposition, for nearly ten months, where the uterus was of a bright red color, firm to feel and cut, its form perfectly normal and recognizable.

Though I do not find it mentioned by any writer, and have not had opportunity to make any observation in the matter myself, it is probable that the prostate gland, also, like the heart and uterus, long resists decay, a not unnatural conclusion when its dense structure is considered. Its examination at a late period after death would only have a medico-legal value where it was necessary to determine the sex in a mutilated body.

In conclusion, it is worth while to present a *résumé* of periods at which some idea of the time that has elapsed since death may be gained from external inspection, as stated by Casper.

(1) The greenish discoloration of the abdomen and the softening of the eyeballs indicate that the person has been dead from twenty-four to seventy-two hours.

(2) After three to five days the green discoloration has become deeper, and has extended over the entire abdomen, including the genitals; while similar patches have begun to appear on other parts, especially the back, lower extremities, neck, and sides of the chest.

(3) In about eight days the greenish patches have coalesced and changed to a reddish green, gaseous products have become developed in the abdomen, the cornea has become concave, the sphincter ani has relaxed, and the ramifications of the subcutaneous veins can be traced on the neck, breast, and limbs.

(4) After fourteen or twenty days, blisters have appeared upon the skin, and the development of gases has become general, distending the whole body.

(5) Lastly, after this period it is impossible to determine the date of the decease.

These data refer to bodies exposed to the atmosphere, and it is assumed that the mean temperature between summer and winter was maintained. Of course, from what has been said, it will be understood that these data must be much modified by a different condition of things; but as a general rule Casper holds that a body, after lying in the open air

will be quite distinctly mapped out on the surface of the arms, neck, and shoulders. Some stress has been laid upon the order of the appearance of these signs of putrefaction as a test for discriminating bodies which have begun to decay in the water from those which began to decay in the air or earth. Casper and Devergie hold this opinion, and it accords with most of the observations made by me; and when we consider what especially favors decomposition, there seems good ground for believing that the bodies of the drowned should show the marks of putrefaction most strongly, as well as earliest, in the upper regions of the body, inasmuch as the things that chiefly favor decomposition are moisture and heat; and as we shall see when treating of death from drowning, in that form of death usually the head, chest, and upper part of the body are much overloaded with blood. But I have noted one case which coincides with Ogston's experience, having met the green discoloration of the body in a case of death by drowning before it appeared on the chest.

I had occasion some ten years ago to examine the body of an elderly man who was found in the water just within reach of high tide, in Boston Harbor. The man had been missing but a short time, less than thirty hours, before the discovery of the body. The clothing was thoroughly wet, and the usual appearances of a body which had lain in the water, such as corrugation of the skin of the hands, etc., were observed. There were many things in the history of the man's recent past which would warrant an opinion of death from suicide, and that the method was submersion; but there was no sign of putrefaction about the head or chest. A moderate amount of rigor was present in the lower limbs, and the lower region of the abdomen from the groins nearly to the umbilicus was of a green color. The section of the body, however, showed clearly the presence of water in the lungs and stomach, a moderate congestion of the solid viscera, and an overloading of the right side of the heart, and no other cause of death. Undoubtedly the appearances in this case were modified by the fact that the man was feeble and had simply lain down in shallow water, and had died from asphyxia without making any struggle.

The pressure of the gases evolved in putrefaction is very considerable, and is not only sufficient to account for the escape of the contents of the alimentary canal, but for more pronounced phenomena, such as the bursting of the coffin after inhumation, and for changes of position in the dead, which have been attributed to the terrible struggles of the prematurely interred. I observed during the intensely hot summer of 1887 a striking instance in point. The body was that of a very large and fat woman, who was a laundress. She lived and worked alone in an upper room of a house in the crowded part of the city, where she was exposed to all the intensity of the summer heat in addition to that of her own stove, heated for the purpose of her occupation. Her absence was not noticed till the second day, as she had no family. The thermometer had registered for those forty-eight hours from 85° F. to 92° F. When the body was found, it was swollen to a third more than its natural size. The tongue was black and protruding from the mouth, and the large intestine was inverted like a glove and protruding for nearly two feet of its length from the anus, while the whole of the exposed parts of the body were covered by thousands of larvæ.

The effect of these same gases is also to be observed in the flow of blood from the wounds made on the bodies of the drowned by the ravages

of marine animals. From the effects of these putrid gases upon the face, there may be such a change in the features as to render an identification of the body by the physiognomy a difficult if not an impossible matter. The decomposition of the upper regions of the bodies of the drowned, after removal from the water and exposure to the air, proceeds with the greatest rapidity. Features which were quite distinct at the time of the recovery of the body may become quite unrecognizable after the lapse of twenty-four hours in the summer.

There is also a change in the color first observed as a sign of decomposition. The red of the superficial veins will change to a brownish black, and the green color of the abdomen and other parts of the body changes to a brown and even to a black.

Simultaneously with the changes produced externally by putrefaction are changes in the appearances of the viscera. The mucosa of the larynx and the bowels present discolorations which might be mistaken for the signs of poison or disease. The mucous membrane of the stomach presents various tints: a reddish brown, a livid purple, or, more commonly, if observed a considerable time after death, a slate color. This slate color is particularly noticeable in the brain where the bodies are examined within a week or ten days after death, provided no means have been used to retard decomposition.

It is by no means easy for the medical jurist always to distinguish between the effects of poison and the effects of decomposition by mere inspection. In both cases there will be redness, and this more or less circumscribed; and an additional element of doubt is presented when the possibility of the action of the digestive fluids themselves is considered. Taylor lays down the rule that the change has taken place during life if it is met in an examination soon after death; yet I have seen many cases where the stomach presented a redness suspiciously like that caused by irritant poison, when death had occurred from natural causes soon after the ingestion of food. When the redness is accompanied by effusion of coagulated blood, mucus, or the effects of ulceration, corrosion, or destruction of the coats of the stomach, we may assume that it was the result of a vital process. In such cases, if there be doubt, the well-known effects of irritant poisons upon other organs, notably the liver and kidneys, should help the solution of the problem, and at all events a properly made chemical analysis of the viscera should absolutely determine the question. A delay in expressing an opinion till the facts are definitely ascertained can do no possible harm, while the opposite course might involve the physician in an awkward dilemma at a later period.

Another point, which will be of service in the differential diagnosis of irritant poisoning during life, and the reddening of the mucous membrane of the stomach after death, is that this redness will be observed in all the other viscera as well. It is especially noticeable in the membranes which naturally have no color. The deep staining of the aorta and of the respiratory canals is an instance in point. It is true, however, that Trouseau and Roget succeeded in producing the appearances of true inflammation upon the bodies of the dead, so far as these appearances consisted in the injection of the vessels rather than the general dyeing of the parts.

As a consequence of the progress of putrefaction the blood becomes fluid, and the action of the gases may change its position to the extent

that it may be forced from the cavities of the heart, where it was in large quantity at the time of death. It is propelled toward the capillaries, and gives to the external portions of the bodies, seen some weeks after death, a diffuse redness differing from the early post-mortem discoloration; and this redness is accompanied by a looseness of the cuticle, which presents a sort of blistered appearance. Moreover, this discoloration affects the true skin, and the subcutaneous areolar tissue is bathed in reddish serum, and the back part of the scalp presents an appearance appropriately compared by Ogston to red-currant jelly.

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a nominally air-tight casket, and afterward exhumed and transported two days before examination. Of course, leanness—and old age, which favors leanness—(aside from dropsical conditions or corpulence), favors slow putrefaction by the absence of an excess of those fluids which naturally hasten this process. Since writing the above I have had occasion to examine the body of a man exhumed after a burial of eight weeks. The cause of death was organic disease of the heart. This body was, in general, in a very good state of preservation. Chiefest to be noted were the large spots of mold upon the cheeks and chin and forehead, while the orbits were filled with a white fluffy mold presenting quite a contrast to the greenish tinge of the mold elsewhere. There were some vesicles as large as an English walnut upon the flanks, purplish in color and full of serum, but slightly tinged. The brain was quite soft, but preserved its form and permitted of sections with a thin, very sharp knife, and the different structures, as, for instance, the corpora striata, were in condition to be fully examined. The heart, as would be expected of an organ which resists decay among the longest, admitted of clear discrimination between the effects of post-mortem change and the fatty infiltration which had occurred during life. The scalp was mummified, rendering its removal rather more difficult than usual; but all the organs were in a better state of preservation than I have seen, twenty-four hours after death, in many cases of septicæmia, where the body had been kept in a moderately cool room.

Various forms of so-called embalming are supposed to prevent putrefactive changes. I have never had occasion to witness the condition of a body at any long period after the injection of the cavities or the arteries with the various so-called preservatives, but in many cases I have noticed that putrefaction proceeded with unusual rapidity after this process, while in none have I seen any difference in the putrefactive change between the embalmed and non-embalmed during the usual period elapsing between death and burial. Of course, much may depend upon the kind of fluid and the skill of the operator; but as far as my own experience goes, this process of embalming tends rather to the obscuring of signs of death from poisoning, and the pecuniary advantage of the undertaker, than to anything else.

Any consideration of the subject of putrefaction would be incomplete without allusion to a change which occasionally occurs at a long period after death, namely, the saponification of the body, or the formation of adipocere. This change is wholly chemical, and consists in the union of the fatty acids with ammonia. It has been oftenest observed in bodies that have lain a long time in water or in very damp soil, where moisture has continuously acted upon a putrefying corpse. There are some other conditions under which adipocere is formed, but the two mentioned are the only ones definitely known. Its formation to any considerable extent usually requires a long time, though it may begin to form at a rather early period. Casper cites the case of one child where adipocere was observed after the interval of only three weeks, and of another child where it was noted after a period of only thirteen weeks; but usually a period of three to four months in the water, or of six months in moist earth, is required before this saponification occurs. It is not necessary that so long a period as many years should elapse before it is formed, as was at one time supposed.

Adipocere is a fatty substance, generally of a yellow color, occasionally of a pure white. It is unctuous or soapy, brittle, and soft to cut. It melts at different degrees of temperature, some requiring no more than 200° F. As it is due to the checking of the colliquative putrefaction, it occurs more readily in the bodies of fat people than in the lean, and children present the change more readily than do adults. In addition to the value of this condition as an indication of the length of time that has elapsed since death, it is of importance to bear in mind a fact to which Günts has called attention, namely, that adipocere is always greater in volume than the total amount of fat preëxisting in the body, and therefore in weighing the body of a new-born child for the purpose of ascertaining the age allowance must be made for the difference.

This saponification of the body has also been termed mummification, but as true mummification is essentially different from the chemical process by which adipocere is formed, the terms should not be used as if interchangeable.

True mummification consists in the rapid evaporation of the watery constituents of the body. This change is favored by very high temperatures with great dryness of the atmosphere, and by atmospheric draught. In this dried state the soft parts are retained, and the features, though distorted, are preserved, and present a rusty brown color. The internal organs have partly disappeared, or are blended together so as not to be distinguished from one another, and they present an odor more like cheese than that of a putrefying body.

Whether occupation has any effect on the process is not known, in spite of the assertion of the First Clown in "Hamlet," that "a tanner will last you nine year." It must be admitted that his assertion that "your water is a sore decayer of your whoreson dead body" is confirmed by medico-legal observation.

At all events, the value of the process of mummification to the medical jurist is, as Casper says, practically confined to the question of the mummification of the umbilical cord in the new-born and the mummification occurring in bodies after arsenic poisoning.

Chronological Order.—Though it doubtless is true that the medical jurist should never refuse to perform an autopsy, irrespective of the time that has elapsed after death, it is well to consider what the relative order of change is, in order that the probability of obtaining any satisfactory data, either as to the cause of death or any other ante-mortem conditions, may be properly estimated. It is well known that certain organs resist decay much longer than others; and in a body where there would be no possibility of determining whether the cause of death may have been natural, like typhoid-fever, or a poison, like hydrocyanic acid, it might still be possible to determine the sex by the discovery of a uterus or a prostate gland, or to determine the question of pregnancy in the female. Even in the bodies of those dead for a number of years, though pathological changes are no longer to be perceived, yet the remains may afford proof of the presence of some of the mineral poisons in the débris.

Therefore the chronological order of the phenomena of putrefaction in the internal organs deserves especial attention. There is practically little difference among authors as to this order. First to present the changes of putrefaction are the trachea and larynx. Whether due to the access of atmospheric air or to imbibition, it is certain that in from

three to five days in summer, and six to eight in winter, the trachea assumes in its mucosa a uniform dirty cherry-red or brownish-red discoloration without vascular injection. This color is to be differentiated from that bright color which obtains in cases of death from asphyxia or from laryngitis. But in these cases both the history of the case and the period after death at which the examination is made will help to determine the question. As putrefaction goes on the mucous membrane becomes olive-green and the cartilages separate from one another, but months elapse before they disappear.

Next in order come the brains of new-born children and those under one year of age. The contents of the cranium of these children are very soft, the access of air is easy, and they are not affected by those changes in consequence of modes of life which sometimes render the brains of adults more durable, as in the case of extensive supplanting of cerebral matter with connective tissue granulations, and their subsequent contraction, which is so often observed in the brains of chronic alcoholic subjects.

The stomach putrefies at a very early period, generally in five to six days, the traces of the change being observed in a dirty red color at the fundus, and this color is at first noted in isolated patches and on the posterior wall, rapidly appearing afterward on the anterior, and then fading into a dirty gray with patches of black, while later the coats become softened. Next in order of putrefaction are the intestines, and the changes occurring there are similar to those which have been mentioned as happening in the stomach. The change caused by bile-staining has already been mentioned. The intestines eventually burst and discharge their contents, and finally become a pultaceous mass.

The spleen is said to resist decay longer than the organs just mentioned, but it is certain that it softens very quickly, and especially in cases of septicæmia. It softens with the greatest rapidity, and may become almost liquefied in some cases, while in others it assumes a steel-gray color with rather more consistency.

If fairly free from fat, the mesentery and omentum resist putrefaction for a period of several weeks, but the process is somewhat accelerated if they are very fat.

In new-born children the liver begins to putrefy earlier than the liver of an adult, which may be found pretty well preserved several weeks after death. I have seen it in a fair state of preservation at a period six weeks after death. The convexity shows the greenish change first, which eventually pervades the whole organ, and as time passes the organ becomes more and more pultaceous. The gall-bladder remains for a much longer time recognizable.

The brain of an adult shows the change of putrefaction first at the base, and a greenish color pervades the whole organ; but the color is not so pronounced as elsewhere, at all events at the earlier stages. The color is more of an ashy gray, and the brain retains this color even after it has become very soft, even to the point of almost liquefaction. I have never observed, as a result of putrefaction, the reddish pulpy condition which is to be observed at a very early period in the brain of the new-born, although that such a condition may be found cannot be doubted, as it has been observed by many writers on the subject. The brains which have been seen by me when they had arrived at a condition of putrefaction have been cases examined, at the farthest, three months

after death. These were uniformly gray and soft, some even to liquefaction; and I admit that it does not seem clear to me where these particular brains were to get the tinge of red at any subsequent period, which Casper says putrefying brains do months after death.

The heart and lungs begin to putrefy at pretty nearly the same time. The heart will be found empty of blood and somewhat shriveled, the pericardial fluid will have evaporated, but still the heart muscle will be clearly recognizable, and, in general, permitting, months after death, and long after the other organs mentioned have passed beyond recognition, a pretty good idea to be formed as to any pathological change. The same is true, in a measure, of the lungs. The structure may be demonstrable, and a differentiation between gray hepatization and putrefactive change may be possible many weeks after death. The diaphragm is a muscular structure like the heart, capable of resisting decay for a long time; but the organ which presents the greatest resistance to putrefactive change is the uterus. This will be found intact after the destruction of the external genitals. Casper cites a case of an adult whose body was in a very advanced state of putrefaction, and which had lain in a privy vault, a condition favoring rapid decomposition, for nearly ten months, where the uterus was of a bright red color, firm to feel and cut, its form perfectly normal and recognizable.

Though I do not find it mentioned by any writer, and have not had opportunity to make any observation in the matter myself, it is probable that the prostate gland, also, like the heart and uterus, long resists decay, a not unnatural conclusion when its dense structure is considered. Its examination at a late period after death would only have a medico-legal value where it was necessary to determine the sex in a mutilated body.

In conclusion, it is worth while to present a *résumé* of periods at which some idea of the time that has elapsed since death may be gained from external inspection, as stated by Casper.

(1) The greenish discoloration of the abdomen and the softening of the eyeballs indicate that the person has been dead from twenty-four to seventy-two hours.

(2) After three to five days the green discoloration has become deeper, and has extended over the entire abdomen, including the genitals; while similar patches have begun to appear on other parts, especially the back, lower extremities, neck, and sides of the chest.

(3) In about eight days the greenish patches have coalesced and changed to a reddish green, gaseous products have become developed in the abdomen, the cornea has become concave, the sphincter ani has relaxed, and the ramifications of the subcutaneous veins can be traced on the neck, breast, and limbs.

(4) After fourteen or twenty days, blisters have appeared upon the skin, and the development of gases has become general, distending the whole body.

(5) Lastly, after this period it is impossible to determine the date of the decease.

These data refer to bodies exposed to the atmosphere, and it is assumed that the mean temperature between summer and winter was maintained. Of course, from what has been said, it will be understood that these data must be much modified by a different condition of things; but as a general rule Casper holds that a body, after lying in the open air

for a week (or a month) at a tolerably similar average temperature responds in its degree of putrefaction to that of a body lying in the twice as long, or after lying in the earth in the usual manner for a p eight times as long (eight weeks or months).

DEATH BY SUFFOCATION.

Death by suffocation is due to the complete arrest of the respir functions, and the consequent interruption of that exchange of the of the external air and the blood gases of the lungs which is nece for the life of the individual, the object of respiration being to su the oxygen necessary for tissue metabolism, and to remove the carl acid formed in the body.

Suffocation is produced in two ways—either mechanically, by turbing or destroying the pulmonary mechanism, or dynamically depriving the blood of the influence of oxygen.

The first class includes: (*a*) injury to the chest walls, or preve of their movement by crushing by weights, or pressure in crowd being buried alive in sand-pits, hay, etc., or by the falling of wal buildings; (*b*) any cause operating on the mouth and nose and th externally, such as covering the face with bedclothes or plasters, c ternal compression of the throat, or a cause operating on the th windpipe, and air-passage internally, such as blocking them up food and plugs of various kinds. Disease itself may furnish an cause of suffocation, such as the complete obstruction of the lary diphtheria, œdema of the glottis, or acute laryngitis.

The second class, which operates dynamically, includes the brea of irrespirable and poisonous gases, though in the case of carbonic and sulphureted hydrogen poisoning the death is not due to asph but to the direct interference with the oxygen-carrying function o blood-corpuscles.

It will be proper first to consider the phenomena of asphyxia, w are usually divided into several stages.

During the first there is hyperpnœa, the respirations being frequent and labored, the extraordinary muscles of inspiration an piration being used. Next the condition of dyspnœa is rapidly prod The oxygen of the blood is used up. The venous blood resulting c lates in the medulla, and causes violent respirations by stimulatin respiratory center. This stage usually lasts about one minute, and place to the second or convulsive stage, in which the inspiratory mu are less active, but the expiratory muscles are very violently agi and the whole muscular system becomes convulsed, the convulsions l due to the stimulation of the respiratory center by the venous b This stage is short, and is succeeded by the third stage, that of ex tion, the respiratory centers being now paralyzed by the venous b Consciousness is abolished, the pupils of the eyes are widely dilate muscles flaccid, reflex acts are suspended, and the only signs of lif a few feeble inspiratory efforts at longer and longer intervals. At as the venous blood circulates in the spinal cord the extremities trunk are extended, there is one last long gasp, and breathing en ceases. After this stage the heart becomes paralyzed, partly by

distention and partly by the action of the venous blood on its walls, the pulse is imperceptible, and the heart stops a few seconds after the cessation of respiration. The whole series of phenomena lasts from three to five minutes, the third stage being the longest.

The post-mortem appearances in death from asphyxia are generally well marked. The right side of the heart, the pulmonary artery, the vena cava, and the veins of the neck are all engorged with blood. The left side is comparatively empty. The blood is fluid and almost black, nearly all of the hæmoglobin being reduced, while ordinary venous blood contains some oxyhæmoglobin. The brain, liver, and walls of the intestines and the kidneys are full of black fluid blood. The mucosa of the larynx and trachea are injected, and the lungs engorged with dark fluid blood. Such are the appearances in death from asphyxia from whatever cause. Let us now consider the appearances which are generally present in death from suffocation, and are especially characteristic of this form of death.

In some cases of death by suffocation the post-mortem appearances may differ, inasmuch as the immediate cause of death may be something other than asphyxia. If the larynx is suddenly constricted or blocked, the death is very sudden, and there is no time for the production of all the phenomena of asphyxia, inasmuch as the suddenness with which the larynx and trachea sometimes become impervious causes such a shock as to result in a very speedy death, the neuro-paralysis of Casper. We have, therefore, to consider those cases by which shock has modified or shortened the manifestations of death, and the alteration in the post-mortem appearances which are the consequence of this modification. The face may be pale or present a dusky violet tint, the eyes are congested, with, sometimes, protruding eyeballs, the tongue is sometimes clenched between the teeth and protrudes, and is sometimes behind the teeth. The mucosa of the larynx and trachea are invariably injected. The lungs may or may not be congested, and sometimes, as quoted by Taylor, one lung may be congested and the other not. Tardieu says the lungs are of a reddish color, sometimes pale, not distended, and only congested posteriorly. One significant sign, especially in smothering, observed in the lungs is the presence of small subpleural ecchymoses. They vary in size from a pin's point to a lentil, in number from five or six to a considerable number, and are due to small effusions of blood from ruptured blood-vessels. These ecchymoses are said, however, to be found in cases of death from asphyxia other than those by suffocation, though admittedly more frequent in the latter. (Legroux, *Ann. d'Hygiene*, 1878, vols. i. and ii., pp. 174, 335.) They have also been seen in new-born children who have never breathed. However, Casper explains this point by saying that "should the exchange of gases necessary for the child's life, which takes place in the placenta, be interrupted by a separation of the placenta, or by pressure on the umbilical cord, or by the death of the mother, then the child makes instinctive respiratory movements in order to maintain this exchange, and so these congestions and ecchymoses are found to occur even in the uterus." These ecchymoses are seen in other parts than the visceral pleuræ, and in one remarkable case of death by smothering, which happened in the writer's experience, the ecchymoses were scattered over the visceral pericardium, over the surface of the liver, and markedly over both kidneys as well as on the lungs.

Both Tardieu and Ogston noticed such ecchymoses on the surface of the neck, and Ogston has seen them on the thymus gland and pericranium. The more rapidly suffocation takes place, the more marked are these ecchymoses, and sometimes in addition to these signs there are ruptures of the air-cells and emphysematous patches on the anterior portion of the lungs.

There is generally a little bloody, frothy mucus in the air-passages. It is obvious that as the appearances here described are also found in other forms of death we must not lay too much stress on any single one, but consider it as one point only in the determination of the cause of death. The presence of ecchymoses on the surface of the lungs would justify an opinion that death was due to suffocation in the absence of other signs, especially when it is remembered that they are most marked in the more rapid deaths from this cause.

We may not find the heart greatly engorged with the black fluid blood of asphyxia, for in cases of sudden death from shock the organ may be flaccid and nearly empty, the action having ceased in diastole. In such cases the other organs would not be markedly hyperæmic.

There are some external appearances seen in death from suffocation, though common also in death from convulsions, and these are the carpopedal contractions, the thumbs being strongly opposed and flexed, and the fingers flexed over them, and the toes showing similar contractions, with only, however, slight opposition of the great toes. After this form of death rigor mortis is said to be slight, or to rapidly pass off.

In a terrible catastrophe which occurred in Sunderland in 1883, about two hundred children lost their lives by suffocation. By the accidental closing of a door, the children, pouring down a staircase and pushed from behind, trampled on those in front, and the bodies were heaped up to a height of several feet. The same appearance was seen in each case, namely, a congested, puffy face, purple turgescence of the vessels of the neck, closed eyelids, protruding eyeballs, pupils widely dilated, with bloody froth issuing from the nose and mouth, giving the appearance of great suffering and anxiety; yet after twenty-four hours much of this passed off, and the face appeared placid, with a slight smile as if in sleep.

It is important to insist on the fact that when the larynx itself is suddenly occluded or compressed, death occurs so quickly that the post-mortem appearances described above are not so pronounced.

So far we have described the post-mortem appearances in those cases where death has resulted from suffocation by mechanical interference with the principal organs of respiration, the lungs; for although the skin is classified as an organ of respiration by physiologists, yet in the annals of medical jurisprudence death by complete obstruction of the pores has never been recorded. There is one case quoted by Foster (*Physiology*), where an Italian boy was covered with gold-leaf to represent an angel, and died a few minutes after the whole body was enveloped, with the signs of asphyxia.

The case of the children suffocated by crowding in a narrow staircase, above quoted, is a good illustration of the signs observed after death from mechanical compression of the chest, with perhaps the additional cause of vitiated air.

Other instances are frequently seen, where the walls of a building have fallen, or where people have been buried under a load of hay or

straw. In the famous series of murders by Burke and Hare, the victims were suffocated by fastening a plaster tightly over the mouth and nose while in a state of intoxication. The bodies were then sold to surgeons for dissection.

Smothering is that form of suffocation which is produced by closing the external apertures of the lungs. This is by no means an infrequent cause of death of infants and young children, sometimes by accident, sometimes by intent. It may be caused by wrapping the head up in shawls or clothing, as occurred in a case at Ayr, where a young woman was charged with the murder of a child by closely investing its head in a shawl. She was acquitted on the defense that she was protecting it from the cold. In large cities many cases come under the notice of the medical jurist in which children have been overlain in bed and suffocated by the breasts or body of the mother or by the bedclothes. In three cases described by Canton, and in most of the cases seen by me, the features were placid, lips congested, eyes slightly prominent, hands clenched, but no ecchymosis of the skin. Internally, the lungs were congested, and there were ecchymoses over pericranium, pia mater, pleuræ, pericardium, and thymus gland.

Homicide by suffocation, except in the cases of young children or those helpless from disease or narcotics, is very rare. The case of a nurse-girl named Norman, fifteen years old, quoted by Taylor, is worthy of mention. She was charged with the murder of three children and the attempted murder of a fourth. The three children showed signs of death by suffocation. The fourth, a boy of ten, was awakened by feeling the girl lying upon him and closing his mouth and nose with her hands, and this was probably the means she employed in the other cases, but the children, being younger and weaker, could not resist as did the boy.

Accidental suffocation may occur in people helpless from intoxication or debility, and the mouth covered over or the throat externally compressed. I am indebted to Dr. Hebbert for the report of the following cases—one a case which happened in London in 1889, and known as the Poplar mystery. A woman was found dead in an alley. The post-mortem signs were those of death from asphyxia. The larynx was much congested, and both aryepiglottic folds were ecchymosed. Dr. Hebbert thought that the death was due to compression of the throat and closing the mouth, as there were bruises on both cheeks and scratches on the throat, and the larynx was so markedly ecchymosed; but Mr. Bond, the well-known English expert, thought the compression was caused by the head falling forward while helplessly drunk, and being compressed by a tight collar. And though the jury brought in a verdict of murder, it did not follow that Mr. Bond's opinion was wrong.

The cases of death from internal occlusion of the air-passages are probably mostly accidental, and frequently due to the impaction of food in the glottis or larynx. In these cases death is generally very sudden. A case of this nature which occurred in London is to the point. The body of a young man was found in the Thames, but there was no evidence, on section of the body, of death from asphyxia by drowning. On examining the larynx it was found blocked by a large piece of partly cooked potato, and some smaller pieces were in the trachea. The heart was flaccid and nearly empty, and the lungs uncongested, so it was con-

cluded that the man died of that form of asphyxia coming under the head of nerve shock, or neuro-paralysis.

Another English case is this (*Lancet*, 1850, vol. i., p. 313): Two men quarreled and fought, and fell to the ground. Two hours later, one of them, rising from the dinner-table, was taken suddenly ill and died in a few minutes; the other was accused of manslaughter, but the post-mortem revealed the cause of death to be suffocation from a large piece of meat wedged in the throat.

A child was brought into the Westminster Hospital in the second stage of asphyxiation. Tracheotomy was immediately performed, but though the tube was inserted no air passed through, and the child died without relief. On examining the body the larynx was found to be filled up by the wooden end of a whistle to which a thin elastic bag was attached. This bag was in the trachea, and prevented the tracheotomy tube from passing down. Death was from acute suffocation.

A dangerous practice is common among nurses, who give little children bags filled with sugar to suck, or even thrust them into their mouths. The children are thus gagged and respire only through the nostrils, and if these become obstructed suffocation might easily result.

A case is described by Littlejohn which illustrates homicide by suffocation. He examined the body of a woman who died suddenly, and found the cork of a quart bottle tightly wedged in the larynx. The sealed end was uppermost, and the opinion was that it was forcibly inserted while the woman was helplessly drunk, and that murder was deliberately contemplated. Her ribs were also fractured.

The following case illustrates death from vitiated air: Two years ago three children, the eldest six years, were playing in a house which was in process of construction. The workmen had gone away, and, in sport, these children entered a small closet beneath a sink, which had sufficient space to barely contain them. They pulled to the door of the closet. It fastened with a spring catch which could only be opened from the outside. The children were missed, and search was made for them, but they were not discovered for many hours. When discovered, two of the children were dead, and the third, barely alive, was resuscitated with considerable difficulty. They were exposed to no noxious vapors, and the only cause appearing was the vitiated condition of the air caused by the exhaustion of the oxygen from the air in the closet by their own respiration.

Five years ago I had occasion to examine the body of a man who had died with the following history: He was a vigorous laboring-man who was eating his dinner hastily in a public restaurant, when he was noticed to suddenly turn exceedingly pale, and, rising from the table, immediately fell to the floor, and expired within less than two minutes. The autopsy showed very great cerebral congestion and engorgement of the lungs. There was no froth in the air-passages, but an examination of the posterior fauces and larynx showed the presence of a piece of beefsteak measuring two inches by one and a half inches, without the slightest appearance of having been masticated, and which served as a wedge to thoroughly occlude the air-passages, and to cause death by sudden and great congestion of the brain.

A clergyman had come from the country for the purpose of having a comparatively trifling surgical operation performed, and was advised by

his physician to be etherized. The physician had neglected to caution him about dining before the operation, and as the man was coming fairly well under the influence of the anæsthetic he had an attack of vomiting, and then expired almost immediately. In this case the autopsy showed the presence in the larger bronchi of two pieces of asparagus stalk, and in the smaller bronchi whole peas mixed with some fragments of food; there was also great hyperæmia of the brain and of the lungs, part of which was undoubtedly due to the effect of the ether; the death, however, resulted entirely from the prevention of the entrance of atmospheric air.

In consequence of the burning of a tenement-house in the city of Boston, a number of Italians, male and female, adults and children, perished. The post-mortem examination of these bodies showed varying appearances. In some there was extensive charring of the exterior of the body, accompanied by numerous vesicles which were filled with serum; distinctly marked burns inside of the mouth and intense redness of the larynx and trachea, but without any marked degree of cerebral or pulmonary hyperæmia. In others the burns were few in number and slight in degree, but the larynx, trachea, and bronchi were reddened throughout, and fine particles of black soot were found even as far as the base of the lungs. The lungs were highly engorged, and there was marked congestion of the brain. In the first-mentioned cases death was undoubtedly due to the effects of burning. In the other cases death was due to suffocation by the inhalation of smoke, and was not influenced in any degree by the burns on the surface of the body.

The term "dynamical asphyxia" is used by Casper to denote those cases in which death is brought about by the respired air, charged with some noxious gas, acting directly on the lungs. Death may occur by this means in three ways:

First, the gas may cause spasm of the glottis, or by entering the larynx cause inflammation, swelling, and occlusion of the tubes. This may properly be called a mechanical cause, but is best considered under the second heading of dynamical causes of asphyxia, as the action may be twofold. Such gases are the pungent vapors of hydrochloric, nitric, nitrous, sulphurous, or other acids. The post-mortem signs would be those of death from asphyxia.

Second, the gas may destroy life by acting in the blood, either by displacing oxygen, such as CO, carbonic oxide, and HCN, hydrocyanic acid, or by reducing the hæmoglobin and robbing the corpuscles of oxygen, as in the case of H_2S, sulphureted hydrogen, where sulphur (S) and water (H_2O) are formed.

Third, the cases in which the air is wanting in, or has been deprived of, the oxygen sufficient for continued life, as, for instance, in vitiated atmosphere, when the CO_2, carbonic acid, is increased in quantity either by over-production, or by the oxygen being gradually used up, ten percent. of CO_2 in atmospheric air endangering life.

As the first division consists of gases rarely causing death, it will be well to pass on to those which are more frequently met with. These are: CO, carbonic oxide, as the result of charcoal vapor, or as a constituent of illuminating-gas; H_2S, sulphureted hydrogen, in sewer-gas; and CO_2, carbonic acid, in mines, ill-ventilated rooms, or as a product of combustion.

Prussic acid vapor, HCN, kills rapidly by displacing the oxygen of

the blood-corpuscles, and then paralyzing the respiratory centers. The blood at first appears bright red and then black. Death is from rapid asphyxiation, the post-mortem signs being similar to those of death when the liquid acid is swallowed. In poisoning with pure CO, carbonic oxide, there is no dyspnœa, the coma not being very marked. There is also temporary but pronounced paralysis of the limbs, followed by spasms. After death the heart and brain are congested with intensely florid blood. In poisoning with the mixed vapors of CO and CO_2 there is a varying degree of coma. There is dyspnœa, muscular spasms, and gradual paralysis and asphyxia. After death the blood-vessels are filled with a bright cherry-colored fluid blood, while the lips, muscles, and viscera have the same color. The brain is soft, the liver, kidneys, and spleen are hyperæmic. The post-mortem hypostases are bright red. The effects of CO on the body are very insidious, and one of the first results is profound languor and loss of muscular strength. It is said that after recovery there may be paraplegia or disturbances of the cerebral activity.

The external appearances after death are quite unlike those of death from gradual asphyxia by choking, the face being usually pale and placid, the eyes bright and not prominent, the pupils dilated, and the tongue not necessarily protruding. Such cases were, and probably still are, common in France, where charcoal-stoves are burned in the sleeping-rooms, but they are also very frequent in American cities and towns, where the illuminating-gas contains a high percentage of carbonic oxide. The following cases illustrate the death from what is sometimes called asphyxia, but what is really carbonic oxide poisoning, due to the inhalation of illuminating-gas.

In the first case the individual was a domestic in the employ of a family in the city of Boston, who had retired in her usual health and was found dead in bed in the morning. There was not the slightest sign of any struggle, and the room presented a distinct odor of illuminating-gas. The bracket which furnished the supply was found to be partially open. It was supposed that the girl had turned the gas down so that there was but a small flame present, and had left her window partially open, and during the night a high wind, which had arisen, extinguished the flame without cutting off the supply of gas. The autopsy showed fluid and bright crimson-colored blood throughout the body, and the same color of lungs, liver, and kidneys. The gas was of the kind known as water-gas, which contains a very high percentage of carbonic oxide; and the fact that the room was not entirely closed, but that there was a window open, and that the amount of gas which must have escaped was small, shows the speed and certainty with which this agent acts, and its deadly nature.

A man coming into the city from the country registered at a hotel, and a room was assigned to him. He retired about nine o'clock in the evening, and at one o'clock in the morning the night-watchman on his rounds noticed a distinct odor of gas, and traced it to the room of this man. A forcible entrance was effected, and the room was found to be filled with gas, the man having either blown the gas out or having turned the stop-cock too far in shutting off the gas. The man himself was unconscious, and breathing heavily. Surgical treatment was promptly afforded him, and he was removed to the hospital, where he was given large quantities of pure oxygen and exposed to a full current of outdoor air, but within twenty-four hours he died. The autopsy in this case showed

in general no crimson color of the blood, which, however, was fluid. The lungs were dark in color in general, but in the middle of each of the lobes of each lung there were found circumscribed patches, varying in size from that of a dime to that of a half-dollar, of the bright crimson color characteristic of the action of carbonic oxide.

Sulphureted hydrogen, H_2S, has a very powerful action on the body. It is said to be instantly fatal when breathed pure, but the cases which come under the notice of the medical jurist are those in which the gas is diluted, as in the foul air from sewers. The victims are usually night-men. The physiological cause of death is due to the rapid destruction of the blood-corpuscles, first by robbing them of oxygen, and then decomposing the hæmoglobin. The blood becomes dark brown to black in color, and under the microscope shows remarkable and complete destruction of corpuscles. (Casper.) The symptoms before death are said to be giddiness, nausea, loss of strength, and paralysis, then convulsions preceding coma and insensibility, or sometimes tetanus with delirium. The skin is cold, pulse feeble, and breathing labored.

The post-mortem signs in six cases examined by Casper were as follows: In two the faces were of a greenish-yellow tint, in the other four they were pale, with anæmic lips; in each case the brain was firm and anæmic, the cortical substance being of a dirty gray color, and the choroid plexuses pale and livid. The lungs were hyperæmic and of the color of black ink, and the blood from the lungs showed the destruction of the corpuscles before mentioned. The heart was collapsed, the right ventricle containing only a few drops of blood, and the left side was empty. There was no froth in the larynx or trachea, and the mucous membranes were of a dark-brown crimson color.

In the cases of four men who lost their lives in the Fleet Street sewer in London cited by Taylor (*Lancet*, 1861, vol. i., p. 187), the blood was black and fluid throughout the body, but the lungs and heart were gorged with blood, and there was froth in the air-passages. The bodies rapidly decomposed. Probably the difference in the post-mortem appearances in the two series of cases arose from the difference in time of the occurrence of death, the more protracted death giving rise to the greater congestion.

In the third class of cases, in which the respired air is wanting in or has been deprived of oxygen, the cause of death is due to the inhaling of CO_2, carbonic acid gas. This kills, not as in the foregoing cases by displacing oxygen, but by preventing its being inspired in sufficient quantity to maintain life. The result may come about by over-production of the gas, as in fires in houses or in mines, or by the oxygen in the air being exhausted by its inhalation by the persons or animals present, and changed in the body to CO_2, the air being in this way overcharged to an amount rendering life in peril. Such a catastrophe happened, for instance, in the terrible "Black Hole of Calcutta," where during the Indian wars several hundred women and children were incarcerated in a small prison, and many died of asphyxia; and there is the historic case of a bride hiding in a chest in Kenilworth Castle, Warwickshire, where the lid of the chest became closed, and the girl was found dead, with her body and limbs distorted by the contractions of previous convulsions.

The post-mortem appearances in death from carbonic acid poisoning are those of asphyxia already described.

DEATH BY HANGING AND STRANGULATION.

Some authors treat these subjects under one heading, while others, as Tardieu, think they should be considered separately. The cause of death in both cases is similar, and brought about by constriction of the throat by an external ligature sufficiently tight to prevent the ingress of air to the lungs. This interference may be sudden or gradual, but the ultimate result is the same—that is, death by asphyxia.

In the so-called judicial hanging it is claimed that death occurs from the dislocation or fracture of the atlas or axis, and consequent pressure by the bone on the spinal cord; and though this may sometimes obtain, these cases only come under the notice of the judicial jurist in his official capacity, as the death is known to the authorities to be necessarily due to hanging. The cases in which he is consulted are those in which he has to determine the cause of death, unknown to any one but the victim or the culprit, and to say whether it may be due to strangulation complete or partial by suspension, or strangulation by forcible constriction of the throat without suspension.

In considering the post-mortem appearances of strangulation by suspension it is found that the principal differences in the external signs are due to the rapidity or slowness of the death. In the violent form of judicial or of homicidal hanging there is lividity or swelling of the face, lips, and eyelids, the eyes are red and protruding, the tongue is livid and protruding or clenched between the teeth, and there is bloody froth about the nose and mouth. There is a deep-red ecchymosed impression of the cord around the hyoideal region of the neck, sometimes with laceration of the muscles and ligaments, or great injury to the larynx and trachea; indeed, even the head has in some cases been nearly torn off. The hands are livid, with clenched fingers, and there are commonly circumscribed patches of ecchymosis about the upper and lower extremities. The urine, fæces, or semen are sometimes expelled involuntarily, and there may be some swelling and congestion of the genital organs in both sexes.

In the cases of suicidal hanging, where death occurs more slowly, the face is generally pale, and the tongue may or may not protrude; the hands are not always clenched. The mark around the neck is a simple depression, acquiring a parchment-like appearance after a time. The internal appearances are those of death from asphyxia, namely, great engorgement of the whole venous system; the lungs, right side of heart, liver, and especially the kidneys and brain, being very full of dark, venous blood; sometimes, indeed, there is extravasation of blood into the substance of the brain. The mark of the cord on the neck is oblique, being lower in front than behind, and may be interrupted in its course. The skin is commonly depressed and brown, hard, or of a parchment-like consistency in the depression, with bluish, ecchymosed edges. Naturally, a difference in the width of the cord would produce a difference in the appearance of the mark, which, consequently, may be wide and superficial or narrow and deep. The latter may be accompanied with abrasions of the skin and subcutaneous ecchymoses, and ruptures of the more superficial muscles, e.g., sterno-mastoid muscles. The condition of the deeper seated parts, such as the elevator and depressor muscles of the hyoid bone, the arteries, nerves, and cartilages in the neighborhood, depends on the amount

of force used, and may be limited to ecchymosis or extend to tearing and fracture of these structures. In the case of the arteries the internal coat and inner layer of the middle coat are torn, as in the ordinary ligature of a surgical operation, while the outer coat may escape. These more serious injuries are seen commonly in judicial executions, while in suicidal hanging the signs are those of asphyxia internally, and the external indications of violence slightly marked.

One very important consideration for the medical jurist is, whether the hanging occurred before or after death. It has been pointed out by Casper that a non-ecchymosed mark similar to that noticed in suicidal hanging may be produced two hours after death. Norman Chevers, in his *Medical Jurisprudence for India*, says that usually the saliva will dribble from one corner of the mouth after suspension during life on account of the drooping of the body to one side. This could not happen if the body was hung after death. Strangulation without suspension is most frequently homicidal. The post-mortem appearances are similar to those by hanging, but the injury to the parts about the neck may be greater. It may be said in regard to the mark of the ligature that it is generally circular, and, as a rule, at or just below the level of the larynx, while in strangulation with suspension the mark is oblique, and most often above the larynx. The damage to the windpipe and the vessels and muscles in its neighborhood is generally considerable, as the force is suddenly and strongly applied. The external marks may not show so plainly as in hanging, for in the garroting period in England the choking was effected by pressure on the throat by the forearm of the assailant, and left little evidence externally; and in the long series of murders by the Thugs in India the strangulation was caused by a soft silk handkerchief twisted rapidly around the throat, and often causing death very suddenly.

In most cases of violent death by strangulation the face is livid and swollen, the eyes prominent, with dilated pupils, the tongue swollen, black, and protruding, and the mouth and nostrils covered with bloody froth. There may also be numerous spots of ecchymosis about the face and neck. The internal signs are those before described as due to asphyxia. It must, however, be remembered that any sudden application of force to the larynx may cause a rapid death, and this was a frequent occurrence in the choking by the Thugs. In such instances it follows that the post-mortem signs are much modified, and the heart will be found empty and the walls flaccid, the lungs not markedly congested, and the abdominal organs apparently normal. The brain is almost always very full of blood, a condition readily explained by the prevention of the return of blood to the heart in consequence of the compression of the jugular veins, and it is this hyperæmia which is the immediate cause of death. A relief of this congestion of the blood-vessels of the brain is the proper treatment in cases of strangulation. Chevers quotes a case of an English officer throttled by the Thugs, who, to make assurance doubly sure, cut his throat, but the ensuing hemorrhage saved his life, by reducing the blood-pressure in the brain.

It will be easily understood that this marked increase of blood in the brain occurs whether the interference of the flow of the blood to and from the brain is sudden or gradual, and is a contrast to the condition seen in asphyxia from suffocation or drowning. A laboring-man, for some time despondent because of ill health, suspended himself from a

beam in his barn and kicked over the stool upon which he had stood in fastening the rope. He was not discovered for several hours, at which time life was extinct. The external examination showed the ordinary pallor and rigidity of the body, and a grooved furrow around the neck, perfectly well marked in front, but slightly so at the back of the neck, and this furrow corresponded in dimensions to the rope which the man had used. The groove was in the region of the hyoid in front. The dissection showed minute ecchymoses on the inferior surface of the skin and in the subcutaneous connective tissues. There was no fracture or dislocation of the bones of the neck. The lungs, brain, and other internal organs presented the ordinary signs of death from asphyxia.

A prominent business man, after an extended indulgence in stimulants, was found in a room in a hotel with life extinct. He had a shawl-strap around his neck. The strap was attached simply to the headboard of his bed, his knees and lower part of legs rested upon the floor. The furrow around the neck was distinctly marked, and corresponded in size with the strap. In this case there were no ecchymoses beneath the furrow, but there was a general engorgement of the lungs and vessels of the brain, and dark, fluid condition of the blood. These signs, considered with the fact that there were no other physical changes, indicated clearly that death had resulted from strangulation.

Another case very similar is that of a person who had attached his suspenders to the post of a very low bed, and had fastened them about his neck and lain down upon the floor in such a position as to bring by the weight of the body a stricture about the neck, and thus cause death. Almost the entire body was resting upon the floor. The post-mortem appearances were similar to those in the case just cited, and death was due also to strangulation.

The appearances of death by hanging may occasionally be found in persons who have died from other causes. In the vast majority of cases, however, persons that are found dead suspended, or partially suspended, may be considered cases of death from suicide, as such means of murder is most unusual. An interesting case illustrating an attempt to conceal a crime by giving the outward appearance of suicide has lately been reported in London. A prominent business man who was left alone in his office in his factory was seen last by the foreman as he left the works at the close of the day's duties. Shortly afterward fire was discovered in the building, and after the flames were extinguished the body of the gentleman was found in an upper room suspended near the fireplace and thoroughly charred; but the examining surgeon discovered by post-mortem examination that it was murder. In this case the body was borne by the murderer through the passage up a staircase, where he deposited his victim on the stairs, then, placing a piece of cord around his neck, set fire to the place, where, if any of the body was left at all, the rope would point to suicide. The fire was kindled at a spot adjoining a chimney, which had for some time past been regarded as dangerous, being partly constructed of wood. Strange to say, though the premises themselves were entirely gutted, the chimney itself was left intact. Moreover, while the legs and thighs, also the greater portion of the arms, of the victim were burned away, and even the features burned beyond recognition, the neck at the back was left to show the mark of the rope and the traces of a brutal assault. The examination was made by Mr. Thomas

Bond, who reported as follows: "The body was charred by fire, both legs and thighs had been burned off, and both forearms. The left upper arm was the only part of the body which was uncharred. This was extended at right angles to the body, and, of course, stiff. The right upper arm was in a sloping position downward. The head and neck were bent down toward the left side. The features were burned away and quite unrecognizable. The hair and scalp were entirely destroyed, and the bones of the skull were charred through in places. On the upper and back part of the skull, on the right side, there was extensive fracture of the bones, and just over the right ear the brain substance was protruding. On moving the charred and fractured fragments of bone on top of the head I found a good deal of brain protruding from the dura mater, or fibrous covering of the brain. The brain was not calcined, but fresh and uninjured. I also found directly under the fractured and calcined bone a large quantity of dark-red putty-like substance. It was quite an inch thick, and lay in contact with the bone on the outside and on the fibrous covering of the brain internally. This putty-like substance extended all over the top of the head. I took some away with me, and I have since analyzed it and examined it microscopically. I find that it is blood partially dried by heat. On the right side of the head below the ear I saw traces—in fact more than traces—I saw a quantity of this red substance adhering to the charred remains, but of course quite dry. This I have ascertained to be blood. On the left side there was none of this substance: the part was simply black and charred. Around the neck, especially the back part of the neck, there was a deepish groove an inch and a half in width and half an inch deep. It showed the indentation of a rope. The groove was quite low down in the neck near the shoulders, and just in front it was just on a level with the lower part of the larynx. Dr. Becker at this point showed me four strands of charred rope, which, he informed me, he had removed from the neck. The rope appeared to fit the groove which I saw around the neck. He told me it lightly encircled the neck and was tied in a knot. Then I found three or four little pieces of rope like that produced lying under the charred remains—under the neck, in fact. The groove I have described was very distinct behind but not so distinct in front. Underneath where the rope had been the skin was protected from the fire and was not charred, though it was discolored; and on making incisions through the skin into the tissues underneath I found there was entire absence of any extravasated blood or of congested blood-vessels.

"The remarkable thing which I found was the extensive effusion of blood between the skull-cap and the fibrous covering of the brain. The brain was also white and soft, and seemed little affected by fire. I have no doubt that this blood was effused during life, and I have no doubt either but that it was caused by extensive fracture of the skull during life. The injuries I found were quite sufficient to cause death, and also to cause death very quickly. Then, again, I am able to say that the death was not caused by strangulation. In death from strangulation or hanging there would be extravasation and congestion under and around the mark of the rope. I examined the larynx also. There was no injury of the larynx, no extravasation of blood about it, or injury to its external surface. Then the condition of the heart and lungs did not point to strangulation. I have no doubt the man met his death from violent

blows inflicted on the head with a heavy instrument, and they were apparently caused by a hammer or some other heavy instrument."

Cases of accidental suspension are also not unknown, as where persons have been caught by a window falling upon the neck while the individual was gazing out into the street; and cases of suspension are well known where children have hanged themselves in sport, and where they have failed to let themselves down before consciousness was lost, and have expired in consequence of the suspension.

DEATH BY DROWNING.

Death by drowning is perhaps the most common form of death from asphyxia with which the medical jurist has to deal, inasmuch as it is one of the most common forms of accident occurring to pleasure-seekers, whether in the yachting-season, or at the time of year when skaters venture on thin ice, or when the hardy sailor is lost overboard in the discharge of his duty, or because of attempts to board his ship when he has yielded to the influence of boon companions during his short stay on land; and, moreover, it is one of the easiest and most frequent forms of suicide.

We say that death is due to drowning when it has occurred in consequence of cutting off the atmospheric air from the mouth and nose by a fluid, irrespective of its density. It may be the water of a lake or the contents of a cesspool, the ooze of the marsh or the fluids of the mother in which a new-born child may be immersed. The quantity of the fluid is immaterial: it may be the whole ocean or it may be the merest pool by the roadside into which an epileptic has fallen during a seizure, and where there is depth of water enough to barely occlude the nose and mouth. In any case of death from drowning the real cause of death is the presence of an excess of carbonic acid in the blood, due to the continuation of the process of elimination, while the vivifying effect of the mingling of the oxygen of the atmospheric air is stopped by the inability of the individual to respire. In this respect it does not differ from any other form of asphyxia.

Death may occur in cases of drowning either by hyperæmia of the brain or of the lungs, or of both combined, or by the sudden paralysis of the whole nervous system. According to Casper, the form of death from cerebral hyperæmia is of the rarest, though undoubtedly most cases of death by drowning are accompanied by some signs of engorgement of the vessels of the brain; but these appearances have been given undue weight by some writers, and the presence of an unusually large amount of blood in the vessels at the posterior part of the brain has been attributed to a vital process, whereas it is far more likely that it was due simply to post-mortem change, as has already been pointed out.

Casper says: "It is, however, certain that even in those rare cases of drowning in which cerebral hyperæmia is found to be the only positive cadaveric phenomenon, except one other special appearance, and must therefore be recognized as the cause of death, this hyperæmia is always relatively inconsiderable, and actual hemorrhage is the rarest of phenomena, and is only observed under very peculiar circumstances." In this connection this author cites a case of a man who fell into a swamp while

drunk. In this case the autopsy showed the presence of the muddy fluid of the marsh in the trachea, but all the other usual signs of death by drowning were absent. The meninges were turgid with blood, and beneath the dura mater was an extravasation an inch in diameter.

The other two forms of death in cases of drowning, pulmonary apoplexy and neuro-paralysis, are of about equal frequency. Just why death should be caused in different individuals by one or the other of these physiological changes cannot be certainly determined, but individual tendencies, temperature of the water, fright, voluntary or involuntary passiveness while sinking, must have some influence.

That there has been much discussion as to whether a decision in a doubtful case of death from drowning could be made is undoubtedly due to the fact that there is no absolutely diagnostic sign which is never wanting; but in my opinion, the difficulties in the way of an accurate diagnosis are much overrated, in spite of the undoubted occurrence of cases more or less puzzling, and where such observers as Devergie and Casper assert that they could "in nine tenths of all the cases declare with a clear conscience whether the submersion had been during life or after death," it is not necessary for less experienced men to assume the rôle of Thomas and demand the utmost proofs before being willing to give an opinion. *À priori*, when a body is found in the water it may be assumed that the individual died by drowning; and though such a death may in rare instances have been the result of murder, and while occasionally bodies, especially of children, are thrown after death into the water to avoid the expense of sepulture, the total number of all these cases is the very small minority.

An exploitation of the various appearances claimed by various writers as characteristic of death from drowning seems unnecessary, inasmuch as most of these have been found to be untrustworthy and of no value as certain signs of death from this cause. I will simply mention them in passing.

Coldness of the body has been claimed as a sign of death by drowning. The fact is that a dead body, whatever the cause of death, as has been mentioned before, soon assumes the temperature of the surrounding media, whether air or water, and bodies submerged in cold water will cool more quickly than those in the air in summer; but the thermometer has as yet been unable to show any difference between the bodies of the drowned and those that have died of other causes after a certain interval, other things being equal. It seems to me, therefore, that relative temperature of a body is of no value as pointing to a death by drowning.

Paleness of the body is also mentioned as a characteristic of the drowned. I have not only seen the bodies of the drowned present a livid appearance, but also a peculiar rosy hue. I have seen the bodies of several people lying side by side in the morgue, some of which had died of natural causes, some by railway accident, one by hemorrhage from cut throat, and one from drowning, and it would have been impossible for any observer to select the body of the drowned man by any difference in color. A statement that there was no difference in color would not apply to the bodies of those who have been long drowned, when the evidence of commencing putrefaction, either in the water or after exposure to the air, is to be seen. Here there is a dusky redness, characteristic not of the cause of death, but of post-mortem change, and it is only

the localization of the color change which furnishes a suggestion of the cause of death.

The situation of the tongue, whether it be behind the teeth, or whether it protrude, or is clenched between the teeth, is of no importance as a characteristic of this form of death. Two days ago I had occasion to make a post-mortem examination of the body of a child who had been apparently well till a few hours before its death, when it was suddenly seized with diarrhœa and vomiting, and after an illness of hours only had some convulsions and died. The child was a negro, and the history suggested an irritant poison; but the autopsy developed the fact that there was œdema of both lower extremities, and acute nephritis with cerebral and pulmonary œdema combined with organic disease of the heart. In this case the tongue was found tightly clenched between the teeth. This is only one of many instances where I have observed the incarceration of the tongue in cases where the death did not result from violence of any form.

The same lack of value attaches to that appearance of the skin known as goose-flesh, or cutis anserina. I had attached some value to this appearance, owing to the instruction in the text-books; but after a very short time I found that the appearance was to be noted in the bodies of those who had died from almost any cause. Indeed, it occurs in the living, as any one will know that has taken a cold bath, or been obliged to make his toilet in a room in the country where the conveniences for heating in the winter time do not obtain. I have had occasion to point out this appearance of goose-flesh to my students in cases of death from pistol-shot, from cut throat, and even from pneumonia. I do not mean to assert that this phenomenon is wholly due to the effects of cold, as it may be observed in the summer as well as in the winter. It is probably largely due to mental or nervous shock, of which sudden exposure to cold may be one cause.

The condition of the hands and feet is of importance only so far as the livid, blue-gray color and the maceration of the epidermis indicate that the body has lain in water. Something resembling this appearance may be seen in the hands of washerwomen during life, and any body, whatever the cause of death, which has been allowed to lie in water after death will present the same change of color and the same maceration. On the other hand, this process requires time, and the body of a person who has been removed from the water within a short time after death, say six to eight hours, will not present the corrugation and maceration which is claimed as a sign of death by drowning.

The absence of sand or gravel from under the finger-nails of the body is of no value, as such appearance is not usually present, and is only to be found where the person has clutched the bank or bottom in efforts to save himself, or where the body has been dragged up a bank in the process of its removal from the water. It is too much of a refinement to suggest that a murderer would endeavor to conceal a crime by attempting to imitate this appearance of the nails.

Casper attaches considerable importance to the retraction of the penis in cases of actual drowning. He has found this condition frequently in the bodies of the drowned, and rarely after death from other causes. He claims that even the distention caused by putrefaction does not prevent this longitudinal shortness from being distinctly observed. When, how-

ever, the very great variation in the size of the organ in different individuals is considered, a very careful observation combined with previous knowledge of the anatomy of the person under examination is required. An instance of this organ assuming more than natural proportions after death from drowning in consequence of putrefactive changes has been previously cited. Casper apparently accepts the explanation of this phenomenon offered by Brettner. This is as follows:

"Bundles of unstriped muscular fiber lying in the upper stratum of the true skin surround the sebaceous glands and force them forward by their contraction, thus making cutis anserina. Precisely similar unstriped muscles are found in the subcutaneous cellular tissue of the penis. They run parallel to the long axis of the member, but very often large bundles run across it. (Kolliker.) It might, therefore, be expected that their contraction would compress the spongy tissues of the penis, which are capable of little resistance, and thus reduce its dimensions in length, breadth, and thickness, and thus produce what might be called a contraction of the penis; and further, that irritants capable of exciting the contraction of ordinary unstriped muscle might also be capable of inducing the contraction of these unstriped muscles of the penis, e.g., cold and fright." It is difficult for me to understand why the same objections to this ingenious explanation which are raised by Casper himself as to the value of cutis anserina as a sign of death by drowning, and which have been previously mentioned, should not lie against the value of the presence of a contracted penis as a sign of this form of death.

So much for the external appearances. On internal examination we occasionally find cerebral hyperæmia. As has already been said, this condition is by no means constant, and therefore nothing can be argued from its absence. If present directly after death, it may disappear with putrefaction, and bodies which have lain in water any considerable time, or which have been exposed to the air after a short immersion, very rapidly take on this change.

The position of the epiglottis is of no value, inasmuch as the upright position may exist in cases of death from other causes, or may be produced in the drowned by manipulation during the course of autopsy.

Of much greater importance is the vascular injection of the mucosa of the trachea and the presence of mucous froth in that canal. In every form of death from suffocation, except that of nervous apoplexy, the mucous membrance of the larynx and trachea is found, on examination soon after death, more or less injected, varying from isolated patches of a cinnabar-red color to a uniform coloration of the whole mucous membrane. This differs distinctly from the dirty-red or brownish-red color of decomposition, and there is also usually in the trachea a fluid varying in amount from a few frothy bubbles to an amount of foam sufficient to fill the entire canal. This wells out of the nose and mouth in consequence of the evolution of gases by putrefaction, and even when absent in the trachea may be forced from the bronchi by gentle pressure. The amount may, and probably does, depend in a degree upon the rapidity or the slowness of the death process. In general, in the bodies of the drowned this appearance of froth, both externally and in the trachea, is only to be found when the body has been removed from the water within a very short time after death, and it would not be found in cases of

drowning where the death was from apoplexy or from neuro-paralysis. Indeed, I have seen cases of pretty sudden death from organic disease of the heart where the amount of foam in the lungs and trachea, as well as externally at the nostrils, was greater than any I have ever seen in the drowned, and which in appearance could in no wise be distinguished from the froth of the drowned, inasmuch as in both cases the foam is simply a mixture of air-bubbles with the fluid either involuntarily inspired or present because of pathological process, or a mixture of air with the mucus naturally contained in the air-canals. Casper and Devergie differ in opinion as to whether it is necessary for the production of this froth in the drowned that the individual should have got his head above water after the first plunge. Casper claims to have found this froth present in the cases of those who have gone at once under the water, and remained there in consequence of coming up under the bottoms of ships or sunken logs, while Devergie maintains that the inhalation of atmospheric air is necessary for the production of this froth. I remember the case of a longshoreman who fell from the side of a ship on which he was employed, and in falling struck his head on a boom beside the ship and never rose after immersion. The body was immediately recovered, but life was extinct. In this case there was no considerable amount of cerebral hyperæmia, the trachea and larynx were injected, and there was froth in these canals and in the bronchi. Therefore it must be admitted that in rare instances such a phenomenon may be present without the inspiration of air after submersion, the froth being formed of the inspired water mingled with the mucus and air that was already in the lungs at the time of submersion; yet while I have had occasion to examine the bodies of many persons who have died under similar circumstances, I have never found the froth except in this solitary case. I am inclined to believe that the presence of froth in such cases is exceptional. I certainly am of the opinion that the amount is largely proportionate to the length of the struggle and the amount of combined air and water inspired. It is unfortunate that this sign disappears so quickly in consequence of putrefaction, inasmuch as the opportunities for examination of bodies of persons who have fallen into the water stunned, or of suicides who have weighted their bodies with stones, or, as in one case coming under my observation, with chain armor, do not come to the surface or are not recovered till decomposition is well under way. If the foam is present, however, the medical jurist will at least be in a position to say that life existed at the time of its formation, and thus dispose of the question whether the body was thrown into the water after death.

No value is to be attached to the position of the diaphragm. It is found variously arched in recent cases of drowning, and, as is well known, may be forced higher and higher by the gases of decomposition.

The increase in the volume of the lungs is a very important sign of death from drowning, though in consequence of my own observation I am not prepared to go as far as Casper, who declares that "it never fails except in the rarest instances, where putrefaction of the whole body and of every organ is already far advanced." I have made dissections of bodies where the decomposition was only indicated by the commencing putrefaction of the soft parts of the head and a moderate greenish discoloration of the surface of the body, and in these cases I have found

the lungs entirely collapsed, and the pleural cavities containing a very large amount of reddish fluid, the result of post-mortem osmosis. I may add that in several of these cases the history of the misadventure was wholly known, and there was no question as to the real cause of death. This increase in the volume of the lungs, however, generally occurs in cases of death by drowning even where death occurred as a result of nervous apoplexy, and is caused by the violent attempts to breathe as the head emerges from the water, and also by the inhalation of the fluid in which the drowning occurs, the latter probably playing the chief part in the production of this phenomenon. The lungs no longer have the crepitant feel of normal lungs, but are very like a sponge, and when these organs are incised there is a copious flow of a bloody froth.

It is of little moment whether water can get into the lungs after death, a point which is much in dispute, inasmuch as the formation of froth is essentially a vital process, and cannot occur after life is extinct. This sign of death by drowning is wholly incontrovertible when in the lungs is found a fluid of peculiar character, and of the same nature in which the body has been found, as, for instance, liquid manure, or liquor amnii. I had occasion to make a section of the body of a man, in a case of suspected murder, where the body was found in a barn cellar in the manure-pit of a stable accommodating a great number of animals. It was shown that the man had come there with a companion for the purpose of carting away the manure at a very early hour in the morning. Both the man and his companion were somewhat intoxicated. After daylight an employee of the proprietor of the stable found the cart still there, while both men had disappeared. Search revealed the presence of one of the men in the half-liquid manure of the pit. His companion, when found, could give no very connected account of what had happened, claiming that he had left the man there when he went away for more liquor, and as he did not find him on his return, went home himself in a dazed way, leaving the team at the stable. External examination showed the absence of all bruises—in fact, there was nothing unusual except the extreme filth of the clothing and body from its environment since death. The volume of the lungs was very much increased, and in the bronchi even of the smaller size there were particles of equine fæces mingled with urine. It was clear that the man had come to his death by drowning in the pit, and the result of the further investigation seemed to make it probable that in the absence of his companion the man had opened the scuttle, and from intoxication fallen into the pit and drowned.

Overloading of the right side of the heart may occur, and generally does in any form of asphyxia, and is not characteristic of the particular form of death by asphyxia which is under consideration. It might be found in any case where the body of a person who had died by strangulation had been thrown into the water after death. Moreover, in the rare cases where death has been due to cerebral hyperæmia or to neuro-paralysis, this condition of the heart is not to be observed. Congestion of the lungs and hyperæmia of the pulmonary artery are also common to various forms of asphyxia whatever the cause, and consequently are not peculiarly characteristic of death by drowning. The dark color and the fluidity of the blood is always present in cases of death by drowning, but it is also present in any case of death where the access of atmospheric air is prevented; and indeed, it is found in cases of death from

narcotic poisoning and from lightning or any other fatal amount of electricity. This has been demonstrated frequently since the introduction of this fluid into general use for power or light. It should be remarked that this condition of the blood, which is always to be found if the body is examined sufficiently early, disappears entirely when putrefaction is considerably advanced.

In regard to the congestion of the solid viscera of the abdomen, as well as the overloading of the vena cava and the mesenteric veins, the same remarks which were made about the hyperæmia of the brain and lungs are applicable. These parts will be found congested in most cases of drowning, but this only means that the death has resulted from asphyxia, though not necessarily from drowning. Of course this hyperæmia is not likely to be found in the organs of those who have died in the water from any other cause than drowning.

Whether the bladder is full or empty is a matter of no diagnostic value. I have frequently found the bladder very much distended with urine in cases of drowning, and on the other hand I have also found it entirely empty. In cities with a water-front it is not at all uncommon to see cases where the body has been found alongside a wharf, and where the condition of the clothing and the emptiness of the bladder have very strongly suggested that the deceased had gone to the side of the wharf for the purpose of voiding urine, and in so doing, or immediately thereafter, had lost his balance from intoxication and fallen into the water and drowned.

The presence of water in the stomach of the drowned is a fairly constant appearance. Its value as a diagnostic symptom is somewhat in dispute. Casper thinks that it is always present in fresh bodies, and that where it is apparently absent the absence is rather dependent on illusion than reality. Ogston claims to have found water present in the stomach in nearly thirty-seven percent. of his cases. In at least fifty percent. of my own cases the presence of water in the stomach has been observed. Ogston further states that in ten of his cases, though there was no water in the stomach, it was present to a limited extent in the abdominal cavity, never to an amount more than six ounces. This suggests to the anatomist the question as to how it arrived in this serous cavity in the process of drowning. However, as it gets into the pleural cavities by osmosis it is possible that it reaches the abdomen in the same manner. This presence of water in the pleural cavities, which I have observed in a very large proportion of the cases of drowning which came under my observation, is, in my opinion, a very important sign. It is to be found at a time when putrefaction has at most just begun. It is tinged with the coloring matter of the blood, and is generally altogether too much in amount to be accounted for by the serum which would naturally come from the blood of a congested lung, and, to my mind, indicates the presence in the lung of a considerable amount of water introduced during the death-struggle. The presence of other pathological changes would of course settle any question as to whether this fluid was the result of an effusion caused by pleuritic inflammation during life. I have found as much as a quart of this fluid in each pleural cavity.

To return to the question of water in the stomach, it has been shown by experiments on animals that water enters the stomach during the process of drowning by the act of deglutition as the animal comes to

the surface to respire, while when they are kept continually under water till life is extinct, little, if any, water enters this cavity. It has also been found by experiment that water does not enter the stomach of an animal thrown into the water after death. The power of swallowing is lost after death, and the walls of the œsophagus apply themselves too closely together to permit the passage of water. Nearly all writers are agreed that water cannot enter the stomach after death, at any rate till putrefaction is far advanced. It must be borne in mind that water may have been swallowed by the deceased just previous to immersion; but such cases are the exception, and if the fluid found in the stomach should be different from the kind of water which would naturally be drunk—sea-water for instance, or a fluid which is never voluntarily drunk, as liquid manure or liquid mud—the proof is positive that death resulted from drowning. The only exception to this is the case of a new-born child. It has been shown that there are movements of deglutition made by the fœtus while in the membranes. Consequently if liquor amnii or uterine mucus be found in the stomach of a new-born child, it would not show that the child had been drowned, as these substances have been found in the stomachs of children who have never breathed. Generally speaking, however, when other substances are found, such as human ordure, it is an indication that the child has been drowned. If there should be any doubt, a careful examination of the lungs as to the matter of their having been distended by natural respiration should be made.

The following case illustrates a manner of death not at all uncommon, but which has given rise to what seems an unnecessary amount of discussion. During the bathing season a few years ago a man was wading in the surf at a seaside resort, and was not in the water at a greater depth than his hips. A female friend, who was swimming at some distance farther out from the shore, in a spirit of mischief cried for help, exclaiming that she was drowning. The man made a violent attempt to reach the woman, but after a few steps fell forward into the water and did not rise. He was immediately taken out, but all attempts at resuscitation proved unavailing. The dissection showed a large, very fatty heart, distended with blood on both sides, no unusual darkness or fluidity of the blood, and no cerebral or tracheal injection, and entire absence of froth in the air-passages. Now, although this death occurred in the water and the body was submerged, the case was clearly one of death from syncope. Owing to the fright and the sudden exertion, a heart in a pronounced degree of fatty infiltration became incapable of work. This might equally have happened on land. Such cases ought not at all to be considered cases of drowning.

During the same season, at another resort, a man who could not swim at all was wading in the water, when he suddenly fell and was submerged. He had been in the water but the shortest time before this happened, but he had just previous to jumping into the water eaten a very large meal and had partaken freely of stimulants. The autopsy in this case showed only very great engorgement of the cerebral vessels without actual rupture. This case should properly be classed as a death from cerebral congestion and shock rather than as a death from drowning, although the death did occur in the water, and it is possible that life was not wholly extinct at the time of submersion.

Something more than two years ago I was called to investigate the

death of a new-born infant in one of the outlying districts of the city of Boston. The mother was a domestic, and was not known by her employer to be pregnant until after the delivery. She was alone at the time of the birth, and claimed that the child had never cried or given any sign of life, and that, believing that it was dead, she had put it into a pail containing various fluids, water, urine, blood, etc. The umbilical cord had been cut but not tied. The section showed that the child had breathed, as the lungs were fully distended, and presented a number of blebs upon their surface (emphysema), and were wholly buoyant in water, both in mass with the thymus attached, and also in small sections after being subjected to great pressure. The lungs were, however, overloaded with blood, and there was cerebral congestion; the bronchial tubes contained a little froth, and in the stomach was found a reddish-brown fluid with an odor of urine, in which were blood-corpuscles. Although this was apparently a case of homicidal drowning, the authorities thought it unlikely that a conviction of an ignorant woman, who was alone in her travail, could be obtained.

I have made post-mortem examinations in very many cases of new-born children, which were said by the parents—and no doubt the statement was made in perfect good faith—to have been still-born, where the section has shown in the stomach the presence of the uterine fluids mixed with blood, while the lungs clearly indicated that the child had breathed, and had afterward died from the prevention of access of atmospheric air. These are cases where the mother was alone at the time of birth, and the child was expelled rapidly into a pool of the fluids of the mother, who may have been in a half swoon herself, and where the child, lying face downward in this mass of fluid, was drowned before anything could be done to remove it from its situation. The new-born child dies in a very short time in such a situation, and the speed with which death ensues prevents the changes which are seen so markedly in the adult.

The question whether any given death from drowning was the result of accident, suicide, or homicide is one most difficult to determine, and very little aid is given in the majority of cases from the examination of the body alone. External circumstances must be carefully weighed, and an opinion given with a great deal of caution, as it is in many cases impossible for the medical jurist to give an opinion which shall be exact. If the body has not too far advanced in putrefaction he will generally be able to state whether the body was alive or dead when it went into the water. In the latter case suicidal drowning would be out of the question, and the question of the homicide by drowning of a new-born child would be settled in the negative if the body was found to have been dead when thrown into the water. This is of importance, inasmuch as many cases come up for investigation every year where the body has thus been disposed of to escape the expense of burial. That the body of an adult should be thrown into the water for such cause is very unusual. Injuries of various kinds may be found upon the body, and they may have been produced both before and after death in various ways. A man may have been wounded and subsequently fallen into the water, or a suicide may resort to drowning after having failed in other ways.

In the summer of 1893 I was called to examine the body of a man which had just been taken from tide-water at the junction of the river Charles. The body had evidently been in the water but a short time.

The post-mortem examination showed all the characteristic signs of death by asphyxia from drowning. Yet in the right side of the head were found two wounds produced by pistol-balls, both bullets having been fired into the head at short range; but as they were of the smallest caliber, and therefore fired with a small charge of powder, they had buried themselves in the skull without penetrating it, and had produced no further effect upon the brain than a trifling ecchymosis directly beneath the site of the bullet. In this case it was clear that the man had been shot and then had died from drowning, and would not necessarily have died from the effects of the shooting. Fortunately, some letters left by the deceased, and an investigation of his financial situation, left no doubt that the case was one of suicide.

A body in running water may be subjected to injuries by being hurled against floating ice, the piers of bridges, or by being mutilated by the propellers or paddle-wheels of steamboats. In such cases great care must be used in the investigation to determine as far as possible whether these wounds show any signs of vital reaction indicating that they were inflicted during life. Moreover, the medical expert must be careful not to mistake post-mortem changes from putrefaction, such as the presence of swelling of the scalp, or blood beneath it, for a process occurring before death. Bodies are often much crushed when lying in tide-water by the weight of a ship settling upon the body as the tide ebbs. Such injuries, however, are so great as to leave little doubt that they were not inflicted during life.

Collateral circumstances may often throw some light on the question of homicide, or suicide, or accident. Certain people, from the nature of their occupation, are liable to accidents of this sort, such as sailors, longshoremen, dyers, icemen, and railroad employees who are required to walk over trestlework. Weights of any kind attached to the body suggest suicide in the case of the adult. The case previously cited of a young man who was found with a suit of chain armor attached by a belt to the body is illustrative. No one knew that the man was inclined to self-destruction; but the fact that he was an actor, and that this suit was a part of his own wardrobe, and some subsequently ascertained facts, clearly demonstrated suicide.

A celebrated case occurring in a county of Massachusetts some two years or more ago is of especial interest in this connection. On or about Christmas eve a young woman disappeared from her home, and some months later her body was discovered in tide-water near a bridge connecting the town where she had lived with an adjoining city. It was asserted that on the night of her disappearance, which was very stormy, she was seen to get into a buggy with a man who was assumed to be her lover and the father of her unborn child. There were some letters which pretended to have been mailed by her after the time of her disappearance, which were written in a hand resembling that of the accused, and these, together with other circumstances, led to the arrest and trial of this man. The autopsy, which was very carefully conducted by Drs. Durell and Swan, was witnessed by myself. The appearances showed nothing of external violence, and only a moderate degree of putrefaction. There was engorgement of the lungs, and the blood was dark and fluid. Both chest cavities contained a large amount of reddish fluid, and the mucosa of larynx and trachea were stained a dark red. There

was about a pint of water in the stomach. There was nothing indicating any other cause of death. In the uterus was a fœtus of the fifth month. The examination of the body showed nothing to indicate whether the death was one of homicide or suicide except the moral evidence afforded by the pregnancy suggestive of a motive for suicide. The contention of the government was that this was also a sufficient motive for murder on the part of the alleged father. It was claimed that because he was for a long time deaf to her entreaties to marry her, at last, to rid himself of her importunity, he, under the pretense of taking her away to be married, had driven to this bridge, and there had taken her out of the carriage and thrown her over. The defense claimed that it would have been impossible for the man to have taken this girl, in the full possession of her senses (and there was nothing to indicate she was not; indeed, the government claimed that she shrieked when thrown in), and thrown her over the high rails of a bridge into the water without using sufficient force to have left marks on her body; and again, that the physical relations of the buggy and the bridge did not admit of his attaining a position where he could have thrown her over either with or without great force; that murder by drowning in the case of an adult was most unusual; and that the motive was entirely insufficient, inasmuch as under the laws he would have had to submit to the penalty only of supporting the child under the Bastardy Act; that suicide of women pregnant with an illegitimate child is of very frequent occurrence; and that the throwing the girl into the water where there was the possibility of her floating to the bank of the river, or of her being rescued, was not the probable act of a man who was ingenious enough to have planned the scheme as outlined by the government, a man who would not have been so shortsighted as to take such a chance.

To show how much the matter was in doubt, it may be stated that there were two trials of the case, in the first of which the jury promptly convicted, and on the second, and with the same evidence practically, the jury with equal promptness acquitted the prisoner. It must be admitted that the entire absence of any marks of violence upon the body in the way of scratches or bruises lent a certain sort of moral weight to the claim of the defense.

The nature and depth of the fluid should be considered, though great caution should be used in forming an opinion of homicide because of the shallowness of the water. An epileptic might have a seizure on the edge of a shallow pool of water and die of drowning because of his inability to assist himself.

In the summer of 1877 I had occasion to examine the body of a man who was found in a very shallow ditch of water in a town near Boston. At the time of finding the body there was scarcely water enough to cover the half of the body when lying prone. The physical signs were clearly those of drowning, and it was ascertained that he had left a resort where he had spent the evening in drinking, quite late on the previous night, and that his route homeward was over a low trestlework crossing the ditch where the body was found, and which, though often dry, was accessible to tide-water, and at about the time that he started for home the tide was high. All of his valuables, including money and a costly gold watch, were found on his person, and the conclusion was warranted that

in a state of intoxication he had fallen from the trestle and drowned, and by the incoming tide the body had been carried a little farther inland.

The answer to the question, How long has this body been in the water? is of importance, but it can rarely be answered with exactness, as has been shown in the part of this article which treats of putrefaction.

DEATH FROM COLD AND HEAT.

While cases of death from extreme cold are of comparatively rare occurrence, they are still worthy of some passing mention in a work of this character. Of course the cases will occur only in the winter time, in the northern part of temperate climates, and in those zones which are known as frigid. The rarity of the occurrence of these cases has left the medical jurist with insufficient data from which to draw accurate conclusions as to the post-mortem appearances characteristic of death from cold.

Out of some four thousand cases of death from violence which have come under my own observation, there was only one case which could be in any way attributed to the effect of extremely low temperature, and even in this case the history was such as to render rather obscure the question whether the death was not caused primarily by the narcotic effect of alcohol, the freezing occurring immediately after death.

From an observation of some nineteen cases, Dr. Ogston says that the peculiar appearance in the bodies of adults who are frozen are: first, an arterial hue of the blood generally, except when viewed in masses within the heart; second, an unusual accumulation of blood on both sides of the heart and in the large vessels, and both arteries and veins above the chest; third, a pallor of the general surface of the body, an anæmia of the viscera largely supplied with blood; fourth, the irregular and dusky red patches on limited portions on the exterior of the body in parts not dependent, and which contrast visibly with the pallor of the skin and general surface. On the other hand, Casper says: "There is not one appearance which can, with any certainty, justify the assumption of death from cold." He mentions also that in cases where the ears, the points of noses, and the fingers are readily broken off, such appearances have been proclaimed as signs of death from freezing. But this condition only proves that these parts of the deceased had possibly been frozen before death. Of course it is not an infrequent occurrence to find, in winter time, on post-mortem examination of bodies, in the hollow organs fluids which have been converted into masses of ice. He further says that the overloading of the vessels of the brain, lungs, and heart, and large venous trunks, any or all of them, is of no real value in the way of demonstrating death from cold, since this condition is found after other kinds of death; so that, really, the diagnosis is only to be made by considering the whole picture in connection with the history of the case, and the absence of evidence of death from any other cause. But Casper calls atenttion to one point of negative evidence, which is this: if a body found frozen is in a state of commencing or advancing putrefaction, it is quite clear that the individual did not die from cold, but that the body had already begun to putrefy before the freezing, inasmuch as ice itself is a preservative.

In regard to the points made by Dr. Ogston, it is said that the arterial hue of the blood is to be found after death in other cases, notably in cases of death from carbonic oxide poisoning. As to the unusual accumulation of blood in both sides of the heart, it is well known that this may be found in cases of death from other causes, as, for instance, in some cases of heart disease. Pallor of the general surface of the body is common to all kinds of death; but as to the dusky red patches which are found in parts other than those dependent, it may be said they are of a certain diagnostic value, but, without corroborating circumstances, would not be in themselves sufficient to warrant an absolute opinion that the death was caused by cold.

It may be said with regard to the persons who most readily succumb to exceedingly low temperature, that they are naturally those people whose vital powers are the feeblest—that is, in the very young and the very old, and those who are narcotized from excessive indulgence in alcohol. And it may also be stated that in the case of the habitual drunkard the pathological changes which have taken place in the tissues of the heart render the circulation more feeble, and consequently render the individual himself less able to withstand the effects of the cold.

The diagnosis of death by freezing must rather depend upon common sense than upon specific changes found on dissection; and although there have been exceptionally rare cases where death from this cause has been attributed to the intentional act of another, in the vast majority of cases such deaths must be looked upon wholly as the result of accident.

Death from the other extreme of temperature—excessive heat—is, on the other hand, of fairly common occurrence. And while the human body is capable of resisting for a brief period a high degree of temperature, a long-continued exposure to a moderately great elevation of temperature, or the exposure a short time to excessively high temperature, results in the destruction of life.

There are notable instances of people who are able to bear high temperature for an extended period—the firemen or stokers in the engine-rooms of the ocean steamers, where the temperature is often from 145° to 150° F. In the Turkish bath the temperature is sometimes from 180° to 200°. In both of these situations deaths have occurred. The first effect of heat is to stimulate tremendously the action of the heart, followed by a feeling of giddiness and suffocation and death by coma; or if the person does not die immediately, it may lead to congestion of the lungs with the attendant fever. Excessive heat, aside from actual burning, kills by producing apoplexy, and the post-mortem examinations in cases of death from sunstroke have shown that the appearances were those of apoplexy.

According to Dr. Tidy, when death has occurred from excessive heat rigor mortis comes on quickly, putrefaction sets in very rapidly, and livid spots and petechiæ are often found on the body. The brain and its membranes are injected, and serum will be found in excess in the ventricles. The lungs are especially dark and injected, particularly the central and posterior parts and the bases. There are often large pulmonary apoplexies. The heart is generally filled with liquid blood, especially on the right side, and the entire venous system is usually congested; and yet these appearances are by no means constant.

PLATE III.

DEATH BY BURNING, SHOWING VESICLES AND CONTORTIONS OF LIMBS.

Death in Consequence of Burning.—Under this head I shall not consider the cases where death is from suffocation by smoke or by the spasm of the glottis in consequence of inhalation of flame. The effects of heat upon the body vary in proportion to the severity, from simple reddening to an entire charring of the body and destruction of the deep-seated parts. Death takes place in two different ways: severe and extensive burns may destroy life from the depression of the nervous system, owing to the number of superficial nerves that are affected; or the victims may suffer from inflammatory reaction and from suppuration and fever at a later period, and they may die from the effects of the destruction of the skin (although the burn may be superficial, yet covering a very large area of the body), the chief gland of the body.

The question as to the connection of certain pathological changes in the interior of the body with alleged burns, which have not during life attracted special attention, is not likely to give rise to a great deal of trouble. It is in cases where the appearance of the exterior of the dead body is suggestive of burns that the question might be raised as to whether the burns were inflicted in life, or whether after death for the purpose of concealment of crime.

The researches of Christison and Taylor, which are practically in agreement, show that the appearance which follows immediately upon the application of heat to the living body is a flush of redness around the burned part, removable by gentle pressure, disappearing in time, and not permanent after death. Next to this in order, following almost immediately after the injury, is a narrow line of deep redness, separated by a line of deep whiteness passing into a blush, but not capable of being removed by pressure. This line of redness may be seen after the application of the actual cautery. The next phenomenon is the appearance of blisters, which may generally, when the agent is a scalding fluid, appear in a very few minutes, as in young children, or may be delayed for hours.

Christison considers that a line of redness not removable by pressure, followed by blisters containing serum, is a certain sign that the burn was inflicted during life, while blisters containing only air may be produced by heat after death. In bodies dead thirty minutes he failed to produce such an effect by boiling water or cauterizing-irons. Dr. Taylor arrived at the same results and same conclusions, though he warns us that the absence of these blisters does not certainly lead to a conclusion that death was not caused by burning.

Casper, after repeated experiments, says: "It is quite impossible to confound a burn inflicted during life with one inflicted after death." The vesicles produced after death are of very small size, do not contain serum, and quickly burst.

Ogston's criticisms on these conclusions are, that we not only occasionally fail to produce vesication by burning during life, but sometimes even any redness at all of the burned part is not perceptible; and, moreover, that vesication without redness on a dead body would not be sufficient to warrant the conclusion that the burn had occurred during life, as such blisters may come from other causes, as was illustrated in the article on putrefaction.

In regard to the matter of so-called spontaneous combustion, although its occurrence has been claimed by as eminent an authority as Orfila, the possibility of such an occurrence is extremely doubtful.

DEATH BY ELECTRICITY.

Death from lightning is well known to occur during thunderstorms in the summer time, and in tropical climates; but now that electricity is so largely in use for furnishing power and light, accidental deaths from this fluid are more than ever common.

In some of the States of the Union this agent is used for the purpose of execution of criminals. The post-mortem appearances in these cases are not particularly marked. There is usually, in death from electricity when used for mechanical purposes, a charring and burning of the parts of the skin which have come in contact with the wires conveying the fluid. An internal examination shows little beside a general fluid condition of the blood, and death in the majority of cases is due to shock or neuro-paralysis.

In a suburban town some years ago I was cognizant of the case of a young man who had just been acquitted on a charge of attempt to kill, and as he was retiring for the night and sitting on the edge of the bed, a bolt of lightning from a thunder-cloud struck the house. Directly afterward the young man was found dead. The bolt entered his room, making a small hole as if from a bullet, directly above his head, and the only mark upon his person was a small purple spot on the top of his head.

The apparent resemblance to the tree under which the deceased had been standing at the time of receiving a fatal shock of lightning found on the body is fancied rather than real, and is only due to the rapid coming on of putrefaction and the showing of the superficial veins.

A case occurring in the year 1892, which was examined by Dr. Stedman, has the following history: This man was an employee in the power-house of an electric-light company. He had occasion to leave his post of duty and walk across the room, when his foot slipped. He grasped an adjacent wire to save himself; the wire was heavily charged with electricity, and the man expired almost immediately. The autopsy showed a remarkable fluidity of the blood, and slight charring of the hand which had grasped the wire. Otherwise there was an entire absence of any pathological change to account for the death.

DEATH BY STARVATION.

Cases of death from starvation are comparatively rare in this country, aside from cases of atresia of the œsophagus and cases of so-called "baby farming," where the child is either insufficiently or improperly fed, and death results either from an absence of food or from inability of the child to assimilate the food with which it is provided.

In foreign countries, and in rare instances in America, cases have been reported where attempts at prolonged fasting for pecuniary gain have resulted fatally, or where persons have lain in apparent trance, or sleep, for such a long period that death has sometimes resulted. The cases of prolonged fasting where there has been no apparent diminution in the weight of the body are always tainted with suspicion, and the imposture has often been exposed.

In cases where death has occurred from starvation the post-mortem

PLATE IV.

ARBORESCENT MARKING PRODUCED BY LIGHTNING STROKE.
(MACKAY.)

examination should show a great diminution in weight, a dryness and shriveled condition of the skin, and the absence of fatty tissue in general. Especially the entire absence of omental fat. The separation of the skin from the muscles is attended with difficulty. The muscles themselves are much wasted, the stomach and intestines are generally found collapsed, contracted, and empty, and their mucous membrane is thin and almost transparent. According to Dr. Martin, the intestines in some cases are not only contracted, but shrunken in length as well as caliber, and appear like a mere cord, as if the canal were obliterated. The solid viscera are small, shrunken, and anæmic. The large blood-vessels are comparatively empty. The gall-bladder is generally full and there is a cadaveric exudation of bile; the urinary bladder, on the contrary, is generally empty.

As minor signs may be noted the sunken appearance of the face, the *facies hippocratica*, the open, staring eyes, generally with dilated pupils, the conjunctivæ sometimes red. The mouth, anus, and other outlets are red and inflamed-looking. Such fæces as are contained in the intestines are hard like bullets, and of dark color. Dr. Woodman has found the thymus gland unusually large and persistent in infants who have been badly fed. (Tidy, *loc. cit.*) This author cites a number of illustrative cases, which are of interest as showing how long life can be prolonged without food.

One is a case of a prisoner at Toulouse, who voluntarily starved himself to death. He lingered till the fifty-eighth day; he, however, did drink water and urine, and died after struggling hours in convulsions. The autopsy revealed unusual pallor of the brain, natural lungs, contraction of the œsophagus, but not of the stomach, which contained a little fluid; reddening and softening and injection of the lower portions of the small intestines, distention of the gall-bladder with thick, black bile, and attenuation of the muscles.

In the case of Sarah Jacob, the "Welsh fasting girl," who died after a total abstinence from food for at least seven days, and who was believed to have been an impostor at the outset of her apparent fasting, but who continued the deception for the purpose of making money until death ensued from her being unable as formerly to obtain food surreptitiously, the post-mortem appearances were not so marked. They were these: the body was plump and well formed, with signs of incipient puberty. There was a layer of fat three fourths of an inch in thickness on the average beneath the skin of the chest and abdomen. The brain was healthy and firm, but the membranes were much injected. The thoracic viscera were healthy, but contained little blood. The stomach contained about three teaspoonfuls of dark gelatinous fluid having slight acid reaction. The small intestines were empty, but the colon and rectum contained about half a pound of fæces in a hard state. The gall-bladder was distended and the urinary bladder was empty, and there was nothing else unusual noted.

In the cases of death from baby farming which I have seen, the appearances have corresponded very closely with the general signs as described by Tidy: great emaciation, absence of fatty tissue, fullness of the gall-bladder, and emptiness and contraction of the alimentary canal. The eyes were also sunken, open, and staring, though the condition of the pupils has been variable.

BLOOD AND OTHER STAINS.

BY

JAMES F. BABCOCK.

In many trials for homicide, especially in cases where the evidence is circumstantial, questions arise concerning spots or stains found upon clothing, weapons, furniture, carpets, walls, or other objects, and the scientific witness is expected to answer whether or not the stains are of blood or some other substance. If blood, are the stains old or comparatively recent? What was their origin? Are they human, or from some domestic animal? Are they stains of venous, arterial, or menstrual blood? Was the blood from a living or a dead body? Male or female? Adult or child?

To some of these questions answers may be given which are perfectly definite and reliable, but as to others it can only be replied that our present knowledge furnishes insufficient data for any certain conclusions.

In giving the results on these matters to which science leads us, we shall first briefly state the various physical and chemical properties of blood as it is found in man and animals, and then fully explain the application of these facts to the practical operations necessary for the solution, so far as possible, of the different questions we have stated.

CHEMICAL AND PHYSICAL PROPERTIES OF BLOOD.

Fresh blood is an opaque and somewhat viscous fluid slightly heavier than water. Its specific gravity, on the average, is in normal blood 1.055, but it is slightly less in women and children. In the higher animals the gravity is substantially the same as in man.

The color of blood varies from a bright scarlet to a deep purple, according as it flows from an artery or a vein. In very thin films as observed in the microscope, it is transparent and nearly colorless. The variations in color of venous and arterial blood are due to the degree of oxidation of the coloring matter, called hæmoglobin; hence, venous blood on exposure to the air becomes brighter, and arterial blood in certain diseases dependent upon a reduction in the supply of oxygen (asphyxia, etc.) is dark. On leaving the body the blood becomes gelatinous (coagulation), the change taking place in from three to fifteen minutes. Gradually, certain portions (coagulum) shrink in volume, and after a period of from twelve to forty hours there is a complete separation into thick red clots and a yellowish watery fluid (serum). The coagulation of the

blood may be hastened or retarded by a variety of circumstances. Moderate warmth accelerates, while cold retards coagulation. Access of air promotes coagulation, hence blood in thin layers thickens more rapidly than when it exposes a more limited surface. Coagulation takes place more readily when the blood flows upon rough surfaces; on cloth blood becomes clotted quicker than upon a smooth marble floor or polished furniture.

Chemical Composition of Blood.—1000 parts of blood contain, on the average, 795 parts of water and 205 parts of solids. The solids consist of albumen, fibrin, coloring matter containing iron, called hæmoglobin, cholesterin, and fatty bodies, various salts and extractive matters. The salts contain chlorin, sulphuric, phosphoric, lactic, oleic, stearic, uric, and hippuric acids, combined with potassium, sodium, calcium, and magnesium. The extractive matters contain small amounts of sugar, leucin, tyrosin, xanthin, creatin, and other substances. When examined by the microscope, blood is seen to consist of a colorless fluid (*liquor sanguinis*) in which are suspended large numbers of cell-like bodies called *blood-corpuscles.*

One thousand parts of the liquor sanguinis and of the blood-corpuscles contain:

Blood-Corpuscles.		*Liquor Sanguinis.*	
Water	688.00 parts.	Water	902.90 parts.
Solid constituents	312.00 "	Solid constituents	97.10 "
	1000.00 parts.		1000.00 parts.

The solid constituents of each of these portions consist of:

Hæmoglobin	298.97 parts.	Albumen	78.84 parts.
Fat	2.31 "	Fibrin	4.05 "
Extractive matters	2.60 "	Extractive matters	3.94 "
Mineral salts	8.12 "	Mineral salts	8.55 "
		Fat	1.72 "
	312.00 parts.		97.10 parts.

The blood-corpuscles in their moist condition constitute about fifty percent. (47.2 to 54.2) of the total weight of the blood, and have a specific gravity of 1.088. The specific gravity of the liquor sanguinis is 1.028.

Of the various bodies entering into the composition of blood, there are only two which are of interest or importance to the medical jurist in his study of blood and blood-stains—*hæmoglobin*, which contains the coloring matter, and the *blood-corpuscles.* The chemical and spectroscopic phenomena produced by hæmoglobin afford positive evidence of the presence of blood, from whatever source it may have been derived; and the microscope, aided by the micrometric measurement of the diameters of the blood-corpuscles, gives all that may be determined concerning the origin of the blood, and whether it be human or otherwise.

Hæmoglobin.—The coloring matter of blood, now generally called *hæmoglobin*, was first described by Le Canu under the name of hæmatin. (*Nouvelles Études Chimiques sur le Sang*, Paris, 1852.) Stokes called it *cruorin*, and showed that it was capable of existing in two forms or states

of oxidation. *Scarlet cruorin* was the name given to the product found in arterial blood, and *purple cruorin* to that found in venous blood. (Stokes, *Proc. Roy. Soc.*, 1864, p. 355.) Sorby described an intermediate body under the name of *brown cruorin*. (Sorby, *Monthly Micros. Jour.*, London, vol. vi., p. 9.) Thudicum and Kingzett adopted the name *hæmato-crystallin*. (*Jour. Chem. Soc.*, London, September, 1876.)

When blood defibrinated by whipping is mixed with a 3½-percent. solution of common salt, the corpuscles are gradually deposited, and the supernatant liquor may be decanted. On washing the deposit with a fresh portion of the salt solution the corpuscles are obtained free from serum. They consist of a stroma or colorless skeleton containing hæmoglobin, a little cholesterin, paraglobulin, fatty matters, and mineral salts. If the washed corpuscles are shaken with water and ether, the stroma, cholesterin, and fatty matters are taken up by the ether, while the coloring matter of the blood passes into solution in the water. On exposure to a low temperature a deposit of crystals is formed. They consist of hæmoglobin. One half its volume of alcohol may be added to the aqueous solution to promote crystallization. Hæmoglobin thus obtained consists of several proximate principles: an albuminous substance, which, when separated, is amorphous and colorless, and a crystalline body, called *hæmatin*, having a formula $C_{32}H_{32}FeN_4O_6$. (Kingzett.) Hæmoglobin is perfectly and freely soluble in water and dilute alcohol. By the action of acids or alkalies, or of any reagent capable of coagulating albumen, it is separated into hæmatin and the albuminous body above mentioned. The same change is produced by long exposure to the air, or by a shorter exposure to air containing considerable moisture or impurities such as are found in the atmosphere of cities. Exposure for a shorter period produces a brown substance intermediate between hæmoglobin and hæmatin, called *met-hæmoglobin*.

Hæmatin.—Hæmatin is insoluble in water and ether, but is very slightly soluble in alcohol. It readily dissolves in ammonia water and in solutions of sodium and potassium hydrate. It is soluble in dilute acids, and especially in dilute citric acid. It is a very stable body, and when once formed may remain unchanged for years. If hæmatin or dried blood is heated with glacial acetic acid and a small amount of common salt, and the solution evaporated, a new combination is produced. It is generally considered to be hæmatin hydrochloride, but was named *hæmin* by Teichmann, its discoverer, and it is by this name that it is generally called. It crystallizes readily from its solution in hot acetic acid. Hæmin crystals are insoluble in water, alcohol, ether, and dilute acids, but are sparingly soluble in ammonia water, and freely soluble in solution of sodium or potassium hydrate.

Recapitulation.—*Fresh and unaltered blood* yields crystals of *hæmoglobin*.

Oxidized blood or *dried blood* contains *hæmatin*.

Dried blood or blood treated with glacial acetic acid and salt yields *hæmin*.

Fresh blood-stains are *bright scarlet*, and *yield their coloring matter very readily to cold water*. Hot water renders the stain more or less insoluble, on account of the coagulation of the albumen, while soap and water have a tendency to fix the color, from the conversion, in consequence of the presence of the alkali, of hæmoglobin into hæmatin.

Less recent stains are *reddish brown* or *dark brown* in color. They contain *met-hæmoglobin.* They yield but *little of their coloring matter to water, while very old stains yield no coloring.* Such stains are soluble in dilute citric acid, and give up their coloring to ammonia water.

Optical Properties of Blood-Coloring Matter.—When a solution of the coloring matter of blood is examined by the spectroscope, certain dark spaces called *absorption-bands* are observed. These bands in number and position vary according to the degree of oxidation of the blood-coloring matter or the presence of reagents. The study of the absorption-bands under different conditions has led to the discovery of a method (spectrum analysis) which may be relied upon with absolute certainty for the identification of blood and for distinguishing it from all other substances. A brief description of the principles involved in this method and the apparatus employed for the purpose is here given.

Spectrum Analysis and the Spectroscope.—When a beam of light is passed through a narrow slit of 1–100 to 1–1000 of an inch in width, and then through a prism and allowed to fall upon a white screen, an elongated colored image is produced containing all the brilliant hues of the rainbow.

If the light be passed through several prisms no additional colors are produced, but the image is lengthened and the colors more widely separated. This image is called the *spectrum.* If it be observed through a magnifying-lens or a small telescope, it is found to be crossed at right angles by numerous dark lines. These lines were first carefully observed by Fraunhofer in 1815, and have since been called *Fraunhofer's lines.* This observer found that the lines always kept their position, provided the same prism and lenses were employed, and he made a map or chart of them. He selected eight of those which appeared wider than the others, and named them by the letters of the alphabet from A to H. These lines have been adopted as standards of comparison for denoting the position of any set of colored rays which may be submitted to examination. Lines A and B are in the red portion of the spectrum; C, in the red, near the orange; D, between the yellow and the orange; E, in the green; F, on the borders of the green and blue; G, in the dark blue; and H, at the extreme end of the violet. Kirchoff in 1859 proved that Fraunhofer's lines were due to the presence of certain gases in the solar atmosphere which have the power of absorbing the same rays of light as those emitted by the heated body producing them. Later it was found that various colored solutions had a similar property, so that light passed through them produces a spectrum crossed by dark bands (absorption-bands), which vary in position and intensity according to the nature of the substance or its strength of solution. An instrument adapted to the examination and study of the spectrum or its absorption-bands is called a *spectroscope.* The ordinary form of instrument such as is used in laboratories for the analysis of colored flames is not adapted to the examination of the absorption-bands of blood, although it may be used in the absence of one specially designed for this purpose, called the *microspectroscope*, and sometimes described as the *spectrum-microscope.* It consists of a series of prisms so arranged that they may be attached to the microscope either above the eye-piece or in the ordinary position of the object-glass. The best forms are provided with a scale, which enables the exact position of the bands to be determined, and a supplementary stage, by which the spectrum of one body may be compared with another, the two

spectra being visible side by side at the same time. Sorby in 1866 suggested the form of instrument generally used. Its essential features are shown in the accompanying outline.

Two rectangular prisms of flint-glass are separated from each other by a prism of crown-glass, and two other similar prisms are attached one on each end of the combination. These are cemented with Canada balsam. This compound prism is mounted in a tube, F, having a cap with an elongated opening at A and a circular stop at B. The tube is constructed so that it may be slipped over the upper lens of the eye-piece. The upper lens, G, is compound and achromatic, and is mounted so that the focus may be adjusted by suitable rackwork or by turning the milled head, H. At I is a slit capable of being adjusted to a wider or narrower

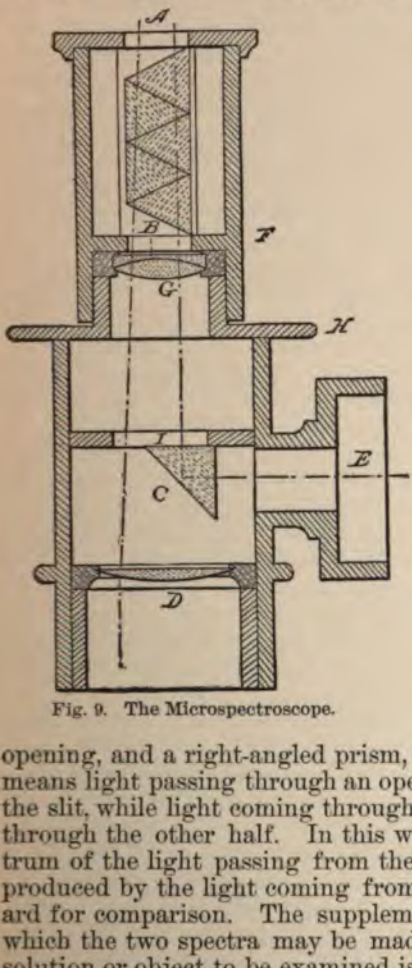


Fig. 9. The Microspectroscope.

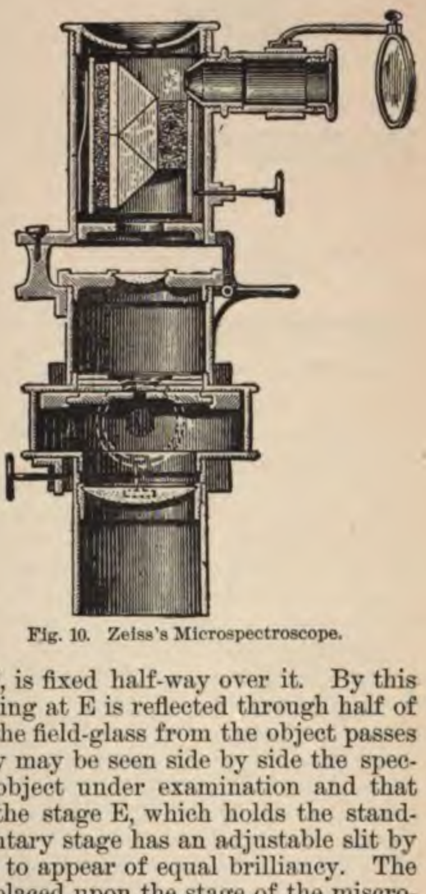


Fig. 10. Zeiss's Microspectroscope.

opening, and a right-angled prism, C, is fixed half-way over it. By this means light passing through an opening at E is reflected through half of the slit, while light coming through the field-glass from the object passes through the other half. In this way may be seen side by side the spectrum of the light passing from the object under examination and that produced by the light coming from the stage E, which holds the standard for comparison. The supplementary stage has an adjustable slit by which the two spectra may be made to appear of equal brilliancy. The solution or object to be examined is placed upon the stage of the miscroscope and strongly illuminated by the mirror; the standard for comparison is contained in a sealed tube held by springs on the stage E.

Fig. 10 represents the spectroscopic eye-piece made by Zeiss. In this

instrument the tube containing the prisms may be turned to one side while the object is being adjusted upon the stage. It has also a scale, an image of which is projected upon the field of the spectrum. It has the disadvantage of being unprovided with the supplementary stage for the comparison of spectra. Messrs. R. and J. Beck of London construct a microspectroscope which is attached below the eye-piece in the position of the object-glass. This form has been highly recommended as being more simple in its arrangement and more easily manipulated, particularly in cases where two similar spectra are to be compared.

For the examination of liquids, glass cells like those shown in Fig. 11 may be employed. The form, A, is made from thick tubing like that used for barometers. About one-half inch in length is cut off, the ends ground to a square surface, and the tube cemented to an ordinary glass slide with Canada balsam. Tubes of varying lengths are convenient for giving greater or less depth of liquid according to its intensity of color. Sorby recommends wedge-shaped cells like B. In these cells the thickness of the solution may be about one-fourth inch on one side and one-fortieth on the other. The effect of varying thickness of the solution is then readily observed. The cells should have a thin cover placed over them, and be completely filled with the fluid under examination. The cover readily adheres by capillary attraction. A reduction of the amount of light transmitted through the slit is equivalent to an increase in thickness of the fluid, so that by varying the width of the opening in the stage attached to the eye-piece the spectrum is modified as much as if a change were made in the depth of liquid. Various methods have been devised for measuring the exact place of the absorption-bands. This is sometimes useful, but it is advisable in the examination of blood-stains to compare the spectrum of the suspected stain with that produced by specimens of known origin, rather than rely upon the position of the bands with reference to the projected scale, since this is liable to variation by various adjustments of the instrument.

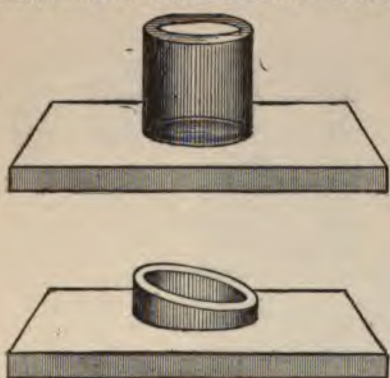
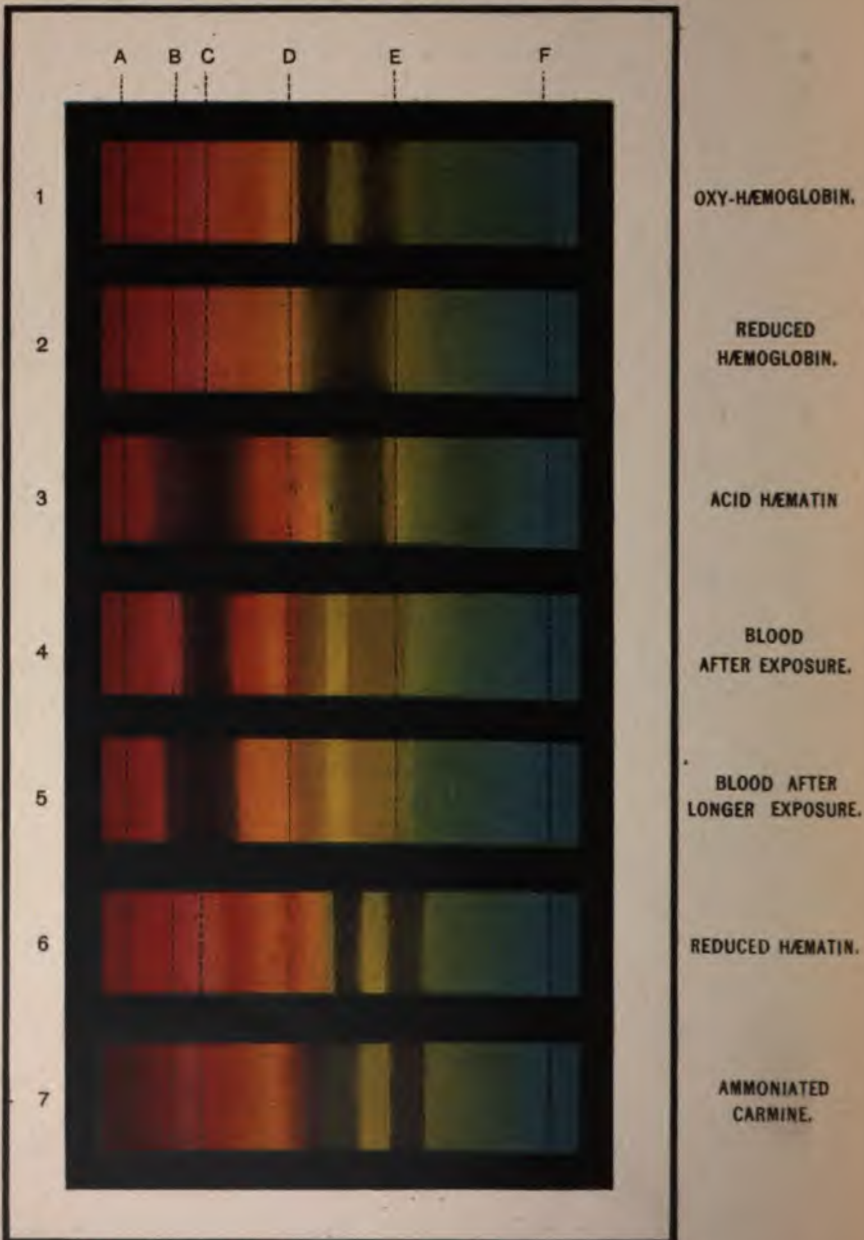


Fig. 11. Cells for the Microspectroscope.

Spectroscopic Appearance of Hæmoglobin and its Derivatives.—When a concentrated solution of hæmoglobin is examined by the spectroscope, all light is excluded except the red. On diluting the solution with water, green and blue light passes, while in the yellow and the beginning of the green portion of the spectrum a dark space makes its appearance. Still further dilution effects the resolution of this dark space into two absorption-bands near the lines D and E of the spectrum: the one nearest D is narrower, darker, and better defined than the other. The band at E has more than double the width of the other, and is somewhat weaker. These bands, called *oxy-hæmoglobin bands*, were discovered by Hoppe-Seyler in 1862. A proper dilution is one part of defibrinated blood in eighty parts of water viewed through a depth of one-half inch. (*Pl. V., No. 1. Absorption-bands of oxy-hæmoglobin.*)

Plate V.



J. F. B. Del.

ABSORPTION SPECTRA.

If to the solution of blood-coloring matter used in the last experiment there be added a drop or two of solution of ferrous ammonium sulphate (double sulphate of iron and ammonia), or a solution of ferrous sulphate mixed with a small amount of potassio-sodic tartrate (Rochelle salt), and then a very little ammonia water, the hæmoglobin is altered chemically (deoxidized), and is called *reduced hæmoglobin.* An examination of the spectrum of this new product shows but one broad band in the place of the former two. This band was discovered by Stokes in 1864, and is called the *reduction-band of hæmoglobin.* It is also sometimes referred to as *Stokes' band.* (*Pl. V., No. 2. Absorption-band of reduced hæmoglobin.*) Agitation with air causes the two bands to reappear. The spectrum showing two bands is characteristic of arterial or oxidized blood, and the single-banded spectrum is peculiar to venous or deoxidized blood.

A solution of hæmatin in a little alcohol to which a small crystal of tartaric acid has been added shows a very broad band in the red (C), another in the green between D and E, and by very careful management of the light a third very faint band in the blue between E and F. If the solution be made strongly alkaline with ammonia the band at C disappears. The subsequent neutralization of the ammonia by acid does not restore it. These bands are called the *acid* and *alkaline bands of hæmatin.* They vary somewhat in number and position, according to the kind and quantity of acid used. (*Pl. V., No. 3. The acid band of hæmatin.*)

A solution of the coloring matter of blood obtained from a stain which has been but a short time exposed to the air shows the two bands of hæmoglobin, but they are weaker than is the case with fresh blood. There is also a third band in the red, near the line C. (*Pl. V., No. 4. Absorption-bands of solution of blood-coloring having but a short exposure to the air.*)

With a solution from blood which has been long exposed to the air the band in the red (C) is wider and darker, while the others are much weaker. (*Pl. V., No. 5. Absorption-bands of blood solution after long exposure.*) The addition of ammonia to such a solution causes the band in the red to disappear, but it causes the bands in the green to become much more distinct.

The effect of reducing agents added to a solution of blood obtained from a stain after prolonged exposure is shown in Pl. V., No. 6. The two bands are much darker, and perfectly well defined. They closely resemble the bands of hæmoglobin, but are a little farther to the right. In very dilute solutions the band at the right may fail to make its appearance.

(Sorby, *Monthly Microscopic Journal*, London, vol. vi., p. 9.)

(Suffolk, *Spectrum Analysis Applied to Microscopical Observation*, London, 1873.)

(Preyer, *Die Blutkrystalle*, Jena, 1871.)

(Thudicum, *Chemical Physiology*, New York, 1872.)

(Rosenberg, *The Use of the Spectroscope*, New York, 1876.)

Crystalline Bodies obtained from Blood-Coloring Matter.—From fresh blood crystals of hæmoglobin (oxy-hæmoglobin) may be obtained which show some differences in crystalline form, according to the source whence they are derived. Blood-crystals were first observed by Funke

in 1851. (*Zeitschrift fur rat. Med.*, vol. i., p. 148.) They may be produced from blood by mixing it with about one sixteenth its volume of ether and shaking the mixture until the liquid becomes a clear lake color. Sometimes the crystals form in a few minutes, and sometimes several days are required to develop them. A single drop of blood should be mixed with a very little ether and covered with a thin glass. Crystals are obtained less readily from the blood of the ox, pig, pigeon, and frog than from the blood of man, mouse, rabbit, and sheep; they are easily obtained from the blood of the dog, rat, squirrel, and guinea-pig. In the majority of animals the crystals are in the form of prisms belonging to the rhombic system; in the guinea-pig they are rhombic-tetrahedra, and in the squirrel they are hexagonal. They have a light-red color when observed with a microscope of low power, and appear of greater or less intensity of color according to their thickness, varying from purplish red to a peach-blossom. The tetrahedral crystals are much more soluble than those which assume the prismatic form, while the solubility of the hexagonal plates is somewhat greater than that of the prisms, but less than is the case with the tetrahedra. The general

Crystals from Man and most of the Carnivora.

Crystals from the Squirrel. Crystals from the Mouse.

Fig. 12. Hæmoglobin Crystals.

appearance of these crystals is shown (after Funke) in Fig. 12. (*Atlas de Physiolog. Chemie*, Leipzig, 1853, Tl. x.) Crystals can be obtained only from fresh blood, or a moist clot not more than a day or two old. They are not characteristic of the blood of any particular genus, since all of the forms have been found in the blood of several different animals.

As already stated, hæmoglobin by exposure to air or by the action of reagents is changed into hæmatin. Hæmatin, being insoluble in water, yields crystals only from its solution in acid. Teichmann in 1853 found by treating dried blood with strong acetic acid in presence of common salt that small crystals entirely different from hæmoglobin were produced. They have been found to be hæmatin hydrochloride, and are commonly called *hæmin*, and sometimes *Teichmann's crystals.* (*Zeitschrift fur rat. Med.*, Zurich, vol. iii., p. 375.) Most minute traces of blood will yield these crystals, and all authorities agree that they can be produced from no other substance. They assume the form of slender prisms with irregular rhombic terminations. They are frequently found in stellate groups and in the form of an X. They vary considerably in size, according to the strength of the solution, and are identical in composition and crystalline form in all of the different kinds of blood which have been examined. Hæmin crystals are obtained by heating a drop of fresh or a small particle of dried blood with a trace of salt and glacial acetic acid. The materials are placed in the center of a microscope-slide and heated until by the evaporation of the acid the liquid begins to solidify. In some cases the microscope shows transparent cubical crystals mixed with the crystals of hæmin. These are due to the use of an excess of salt, but the two kinds of crystals are readily distinguished by their difference in form, color, and solubility.

(Halliburton, *Text-book of Chemical Physiology*, London, 1891.)

(Gamgee, *Physiological Chemistry*.)

The Action of Chemical Agents upon Blood.—*Water.*—Fresh blood mixes freely with cold water, and forms a bright-red solution. The color, as already stated, is due to hæmoglobin. By continued exposure this body becomes less and less soluble, owing to the production of met-hæmoglobin, and finally, when converted into hæmatin, the blood-coloring matter is quite insoluble in water. The action of water upon blood-stains is therefore variable according to the age of the stain. Comparatively recent stains are soluble, older ones less so, and very old stains may be wholly insoluble. Sometimes the latter may be soaked in water for weeks without the liquid becoming in the least degree colored.

Ammonia and the Alkalies.—Ammonia added to a solution of blood, if in small amount, has no effect upon the color except to make it a little brighter and clearer. If a larger quantity or a very strong solution be employed, the red color becomes brown. Solutions of caustic potassa or soda produce a dirty green color with stains on linen. Old stains upon cloth or portions of dried blood are dissolved by dilute ammonia water on soaking, and especially by the aid of a gentle heat. Solutions of potassa or soda acting upon stains give them a darker color before they are fully dissolved.

Effect of Heat.—A solution of blood is coagulated by boiling. On continuing the heat, a more or less voluminous precipitate, according to the strength of the solution, makes its appearance. The precipitate is reddish brown in color, and consists of albumen rendered insoluble by the heat, combined with the coloring matter of the blood. The precipitate is readily soluble in ammonia water.

Bleaching Agents.—Chlorin water, solution of sulphurous acid, and solution of sodium hypochlorite (the so-called chloride of soda) have but little effect upon the color of blood unless the solutions are concentrated

or heated with the blood. Acids of all kinds coagulate the albumen of blood, which, on precipitation, carries down the coloring matter.

Tincture of Galls.—A tincture of galls or an alcoholic solution of gallic acid produces a reddish precipitate, containing the albumen and coloring matter.

The reactions of ammonia, bleaching agents, and of tincture of galls are peculiar to blood. All other soluble red colors are differently affected. They are changed to a green, blue, purple, and in some cases a crimson color by dilute ammonia. Vegetable colors are readily bleached, and certain compounds of iron which are reddish brown in color are changed by the tincture of galls to a bluish black or a bluish green.

Alcohol, Ether, Chloroform, etc.—Dried blood is insoluble in strong alcohol, ether, petroleum benzin, or chloroform. The coloring matter of dried blood is soluble in nearly all of the acids.

Tincture of Guaiacum.—When a small quantity of a freshly made solution of guaiacum resin in alcohol is added to blood either in a pure state or mixed with a large amount of water, there is a precipitation of the resin which renders the liquid milky white. If now a few drops of hydrogen peroxide be added, there is at once produced a beautiful sapphire-blue coloration of the liquid. Particles of dried blood or stains upon cloth give the same reaction.

The Blood-Corpuscles.—When a very thin film of fresh blood is examined by the microscope under a power of two hundred diameters, it is seen to consist of a clear and nearly colorless fluid, in which are suspended an innumerable number of isolated cells having a reddish-yellow tint, called *blood-corpuscles.* Seen flatwise they appear as disks, while edgewise they show a depression on each of the sides, which gives them somewhat the appearance of a thin rubber ball compressed in the central portion by pressure between the fingers.

Corpuscles were first observed by Malphigi in 1661 in the blood of the hedgehog, but he considered them merely globules of fat. Leeuwenhoeck in 1673 detected them in human blood. The early observers of these bodies thought them spherical in form, and called them blood-globules; but Hewson in 1770 showed that they are not spheres, but disks. Young in 1813 inferred that their flat surfaces are depressed in the center, but the fact that they are bi-concave disks was only finally determined by Hodgkin and Lister in 1827. Further study of the blood showed that it contains two other kinds of corpuscles—*white corpuscles* and the so-called *blood-plates* of Hayem, discovered in 1878.

The red corpuscles are by far the most numerous; the white ones are found (in normal blood) only in the small proportion of one to about five hundred of the red, and the blood-plates to the extent of about one to twenty of the others. Neither the white corpuscles nor the blood-plates have any importance in the examination of blood-stains, and it is unnecessary to consider them further.

A comparative study of the red corpuscles of the vertebrates shows considerable difference both in size and form of these bodies as they exist in the various classes. With a few unimportant exceptions, the corpuscles of the mammalia are circular, while those of the ovipara are oval. In certain of the ruminantia, including the camel, dromedary, llama, and alpaca, the corpuscles are oval; in the Mexican deer they have

a variety of forms—circular, heart-shaped, crescent, etc., even in a single individual. (Gulliver.) The lamprey and a few fishes of the cyclostoma have circular disks, which, like those of the mammalia, are slightly depressed in the center. In the corpuscles of all of the ovipara there is found an aggregation of granules called a nucleus, which gives them a raised center. The addition of acetic acid to such corpuscles renders the surrounding parts more transparent and makes the nucleus more distinctly visible. In all of the mammalia there is an absence of this nucleus, and the corpuscles have a depressed center. Under certain conditions of light and focus circular corpuscles appear to have a dark center, but this is the effect of refraction due to the lenticular form of the disk. Fig. 13.

Fig. 13. Blood-Corpuscles from the Mammalia and the Ovipara.

shows the appearance of the round and of the nucleated oval corpuscles. The round corpuscles at 1 are represented as being sharply focused, while at 2 they are shown within the focus. Just beyond the focus they have the center dark and the periphery bright. The effect of acetic acid upon the nucleus is seen at the extreme right of the figure.

The size of the corpuscles varies considerably in the different classes, and is variable within smaller limits in animals of the same class, and even in the same animal. The diameters of the corpuscles bear no relation to the size of the animal. They are larger in the mouse than in the lion, while the ox and the horse have corpuscles considerably smaller than those in man. The largest corpuscles are found among the batrachia; the long diameter of the corpuscles of the eel-salamander (amphiuma) is 1–350 of an inch. The smallest corpuscles are found in the musk-deer. In this animal their average diameter is 1–12,000 of an inch. The corpuscles of the reptiles are the largest; next in size are those of fishes and birds. Mammalian corpuscles are the smallest of all. Among the latter class a few genera have corpuscles somewhat larger than man, but in the majority they are smaller. Gulliver made careful measurements of the diameters of the corpuscles in nearly six hundred genera. His tables may be found in the *Proceedings of the Zoological Society of London* (1875, p. 474). All of Gulliver's measurements, with some additions, are given in Milne-Edwards' *Treatise on Comparative Physiology*. (*Lecons sur Physiologie, etc.*, Paris, 1857, vol. i., pp. 83–90.)

The number of red corpuscles found in a single drop of blood is very large. Five million of these bodies, according to Vierordt and other authorities, is the estimate of the number contained in a cubic millimeter (one twenty-fifth of an inch)—a volume not larger than the head of a small pin.

The structure of the red corpuscles is generally believed to consist of a network of albuminous fibers attached, according to some observers, to the outer hardened layer of the protoplasm of the corpuscle, and according to others to a cell wall or investing membrane. The cell thus formed holds a fluid which contains the blood-coloring matter, or hæmoglobin. In consequence of this structure the corpuscles exhibit the phenomena of endosmose and exosmose. If placed in water—a liquid of less specific gravity than that contained in the corpuscles—the water penetrates into their interior, increases their volume, and thereby causes them to become spherical. This change is necessarily accompanied by a reduction in diameter amounting to about one third. A human blood-disk having a diameter of 1–3300 of an inch if placed in water becomes a sphere of about 1–4500. The oval corpuscles of the ovipara act in the same manner, and, except for the presence of the nucleus, appear like those of mammalian blood. On the other hand, if corpuscles are immersed in a liquid of high specific gravity, as a solution of sugar or of sodium sulphate, the fluid in the interior passes into the outer liquid, and the sides are brought closely together and the corpuscle becomes shriveled and the edges crenated. Weak solutions of the alkalies and dilute acids dissolve the substance of the corpuscle and speedily destroy it. Concentrated solutions of the alkalies (thirty-three percent.) act much more slowly, and form a very good medium for separating the corpuscles from a mass of dried blood under microscopic examination. A solution of common salt, glycerin, or other substance not capable of acting upon albumen, if of specific gravity substantially the same as that of the serum of the blood, may be mixed with the blood without producing any distortion or dissolving effect upon the corpuscles.

THE PRACTICAL TESTING OF SUSPECTED STAINS.

Preliminary Examination.—Before proceeding to the actual tests, every article of clothing, instrument, or other object upon which stains are suspected should undergo a minute inspection, and memoranda of the details put in writing, as follows:

(1) Date and time of day when the specimens were received.

(2) From whom the specimens were received, together with all particulars as to condition of the packages, seals (if used), place where the specimens were received, etc.

(3) A detailed list indicating every article submitted for examination.

(4) The number, size, shape, and exact position of the suspected stains.

(5) If the stains are upon clothing or other fabric, note the side on which they occur. Examine particularly all the pockets, linings, buttons, and seams. These portions often contain minute clots which escape casual observation.

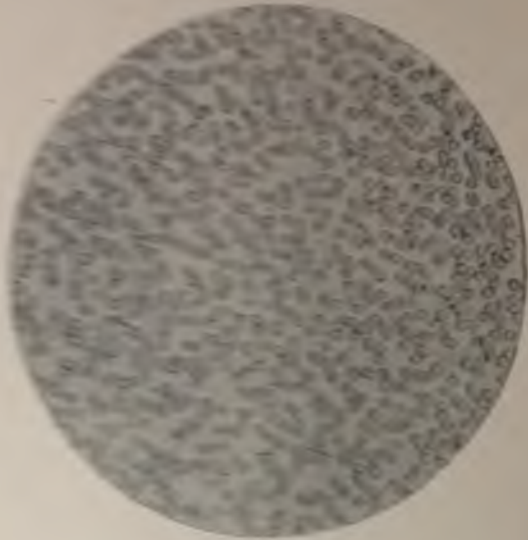
(6) If there appear to be drops, spatters, or smudges upon any of the objects, note the direction of the spatters and the appearance of the drops. (See remarks below on direction of spatters, etc.)

Observe also the following precautions:

(1) When not in use, keep the specimens under lock and key.

(2) As the examination proceeds, each spot tested should be marked

PLATE VI.



[illegible] DIAMETERS.

[illegible] DIAMETERS.

HUMAN BLOOD CORPUSCLES.

[illegible]

In the case of clothing this may be done by securely pinning a small piece of white linen to the side of each spot or place from which it is taken, and marking it in ink with a designating letter or figure. Chips of wood cut from the floor or furniture, and other small specimens, should be kept in separate small vials properly labeled. Spots upon weapons may be sufficiently indicated by descriptive notes.

(3) If possible, use only a portion of each stain for the examination. In the case of minute spots the whole may be required for the necessary tests, but in all other cases reserve a part of the material. It may be required for additional tests or further examination in consequence of facts developed during the trial, and possibly the defendant's counsel may desire a portion for the inspection of his own experts. In the latter case deliver nothing except upon a written order of the prosecuting officers.

(4) Keep accurate notes of every detail of the examination as it proceeds.

The Appearance of Drops and Direction of Spatters.—Drops of blood from a height of one or two feet are larger than those falling only a few inches. In the first case the circumferences of the spots are deeply indented, but in the second they show a perfectly regular outline. (Fig. 14, *a* and *b*.) Spatters indicate their direction by the smaller extremity. This is always farthest from the point of origin (*c*). An impression of the end of the thumb is represented at *d*. Drops of blood when examined by the aid of a small hand magnifying-glass show that their edges are slightly raised above the level of the central portion.

Fig. 14. Blood Drops and Spatters.

The Appearance of Blood-Stains and of the Substances which resemble them.—The appearance of recent blood, either fluid or in a dried state, upon the surface of cloth, wood, or metals, is so characteristic that it is unlikely that any other substance will be mistaken for it. When, however, the blood is of greater age and present only in small spots or stains, and especially upon a dark fabric or surface, it is much more difficult to determine its character.

Small spots upon clothing should be marked by a pin stuck into the cloth near the stain. Unless this is done it will sometimes be difficult to find a given spot when it is again looked for. Considerable time may be saved by attention to this precaution. An ordinary hand magnifying or reading-glass will be found useful for the preliminary inspection. The observer should place the article about to be examined in a horizontal position between his eye and the source of light. The article

should be held at different angles, so that the light may be reflected from the spots somewhat obliquely. Under these conditions blood-stains present a peculiar dark-crimson reflection, which is strongly indicative of blood. Blood-stains, if of any considerable size, upon silk, woolen, or cotton, give a stiffness to the fabric from the drying of the albumen, like that produced by gum; they are glossy and smooth, and have a reddish-brown color. Stains on dark surfaces are best observed by artificial light.

In 1833 a murder was committed in Paris, but the most careful examination of the apartment occupied by the suspected parties, and which was believed to have been the place where the homicide occurred, failed to reveal the slightest appearance of blood. The experts of the government, Ollivier and Pillon, on making further investigation, about eight o'clock in the evening discovered upon the wall-paper a large number of small spatters of a dull red color, which by daylight had the appearance of black points or dots, which were very easily concealed by the design upon the paper; they observed, also, many similar spots on the front of a chest of drawers the wood of which had a deep-brown color. These spots proved to be blood. Other experts, Leseur and Barruel, failed to find the spots on the following day, and were obliged to employ the light of a candle to detect them. (*Archives de Médecine*, 1833, second series, vol. i.)

Drops or clots of blood upon metals or any hard surface are not adherent, and readily scale off when dry. If the spot is very thin or merely a smudge, it will probably be necessary to scrape it lightly with a penknife if it is desired to remove it.

There are many substances which in small stains look somewhat like blood, but they may, in most cases, be easily distinguished by characteristics peculiar to each.

Iron-rust, Corrosions upon Metals by Lemon Juice, Vinegar, etc.—The appearance of iron-rust varies considerably in its different forms. Some of these closely resemble dried blood. The rust upon iron or steel instruments due to contact with lemon juice, vinegar, etc., has been mistaken for blood.

Orfila mentions the case of a man suspected of murder in whose possession was found a knife apparently covered with blood. A chemical examination of the spots showed that they were due to citric acid. The knife had a few days before been used for cutting a lemon, and had been put away without being wiped.

In the case of rust, its character may be determined by carefully detaching a small portion, putting the same into a porcelain capsule in contact with pure hydrochloric acid, and applying a gentle heat. If the spot be iron-rust, the particles are dissolved and form a yellow solution. A drop of this may be tested by a solution of potassium ferrocyanide, which produces a blue color. Alkalies change the blue color to a reddish-brown precipitate. Another drop gives with solution of potassium sulphocyanide a deep-red coloration. A report by Robin upon the distinctive characters of blood-stains found upon an instrument covered with rust may be found in the *Annales de Hygiene*, 1859, vol. xii., p. 150. Stains of iron-rust upon linen may be tested in a similar manner. A small piece cut from the fabric is boiled with pure hydrochloric acid to form a solution, as in the previous case. A portion of the unstained

fabric should be similarly tested, since salts of iron are frequently employed as mordants in dyeing and calico-printing.

Extracts of Dye-woods and Tanning Materials.—Various commercial extracts used by dyers and tanners closely resemble dried blood. Among the most common of these are *extract of hemlock bark, extract of logwood, cutch, catechu, madder, cochineal and its compounds.* All of these are soluble in water, giving brown solutions in the case of logwood, hemlock, cutch, and similar extracts, and red solutions where madder and cochineal are present. Solutions containing logwood, hemlock, cutch, or other astringent drugs become black upon the addition of a few drops of solution of ferric chloride or of tincture of perchloride of iron. Extract of logwood becomes bright red in presence of the stronger acids. Colors of more or less red shade are derived from *Brazil-wood, red sanders, and anatto.* Anatto yields an orange-yellow color to water, and is slightly intensified but not changed by ammonia; acids change its color to a red or pink. Most of the red dye colors become crimson or deep red on the addition of ammonia. Madder is changed to a yellow by acids, and on the addition of iron salts becomes brown. All of these colors are bleached by chlorin water, which, unless very concentrated, has no effect upon blood. A case in which blood-stains found upon the clothing of a prisoner were claimed to be catechu, with a report of tests upon the same, is given in *Guy's Hospital Reports*, second series, vol. vii., p. 413.

Spots of Grease or Tar.—These may be detected by covering the stain by a piece of white filter-paper and pressing with a hot iron, when more or less of the material will be absorbed by the paper. Grease and tar are insoluble in water, but readily dissolve in petroleum naphtha, oil of turpentine, and ether. (See report of a case of this kind in Casper's *Forensic Medicine*, vol. i., p. 202.)

Fruit, Wine, and other Vegetable Stains.—Such stains do not cause any stiffening of the fiber of the fabric, and they are turned blue or green by ammonia. They are readily distinguished by proper tests, but sometimes have a strong resemblance to blood. Taylor reports a case of this kind. (*Medical Jurisprudence*, third American edition, p. 217.)

A farmer's boy was arrested on a charge of murder. The blue blouse and trousers which he had worn had on them numerous brown and red stains resembling blood, and appearing to have been produced by the wiping of bloody fingers. The stained articles were subjected to chemical analysis, and it was found that the color was produced by some sort of vegetable juice. The accused stated that the day before his arrest he had collected a large quantity of red poppies which had become bruised by trampling on them, and that he had carried them home in his blouse.

Red Paint.—Dried paint consists of a mixture of oil solidified by oxidation, and a pigment, generally of mineral origin and in red colors, most commonly oxide of iron or red oxide of lead. It is insoluble in water, but on soaking in naphtha, oil of turpentine, or in a strong solution of alkali it is softened and removed. A small portion may be so treated in a watch-glass, in which, after a time, there will be found deposited the mineral pigment, which may be tested for iron as already indicated. Red lead is so different in color from iron that, like vermilion, its appearance is sufficiently indicative of the fact that it is not blood.

In 1840 a person was murdered at Islington. An individual was

arrested on suspicion, and in his possession was found a sack having upon it many red stains, which were supposed to be dried and coagulated blood. On analysis they proved to be due to red paint, containing peroxide of iron. The sack was shown to have been worn the day before by a youth who was an apprentice to a paper-stainer. It had been sent to the accused a short time previously as a wrapper to a parcel. (Taylor.)

THE VARIOUS METHODS OF TESTING BLOOD-STAINS.

Of the various tests for blood which have, from time to time, been proposed, there are but four of much value or importance. Two of these depend upon chemical and two upon optical principles. They are:

(1) *The Guaiacum Test*, which consists in the production of a blue color from a blood-stain treated with tincture of guaiacum and hydrogen peroxide.

(2) *The Hæmin Test*—the formation of microscopic crystals of hæmatin hydrochloride.

(3) *The Spectroscopic Test*—the identification of the absorption-bands peculiar to hæmoglobin and its derivatives.

(4) *The Histological Test*—the microscopical observation and measurement of the blood-corpuscles.

Where the size of the blood-stains to be tested is such as to furnish a sufficient amount of material, separate portions may be used for the different tests; but in case only a very small stain is available, and it is desired to make several examinations, we may proceed by the following process, suggested by Richardson: The clot or scrapings from the stained portion of the article under examination is placed in the center of a thin cover-glass, and upon this is deposited a minute drop from a capillary pipette of a solution of one part of glycerin in seven parts of water. The cover is inverted over the cavity of a concaved slide and allowed to remain until the coloring matter of the blood has given a decided tinge to the liquid. The drop may then be examined by the microscope for the presence of corpuscles, and afterward, without removing it from the slide, in the microspectroscope. A very minute portion of the same may be tested by the guaiacum reaction. (*Philadelphia Medical Times*, 1875, p. 78.) Special methods for making a solution adapted to each of the tests to be described will be given in their appropriate place.

The observer should make as many tests as possible. If only one test can be made, it should be that which will detect the presence of corpuscles. Next in importance is the hæmin test. This can be made from the specimen used for the microscopical examination, provided that Richardson's fluid (three-fourths percent. salt solution) is employed for soaking out the corpuscles, but not otherwise. The guaiacum test may be made upon the hæmin crystals, or indeed under nearly all conditions.

THE CHEMICAL TESTS FOR BLOOD.

Thirty years ago the chemical methods for the examination of suspected blood-stains consisted only in the identification of certain properties and constituents which are, at present, seldom or rarely consid-

ered in studying the subject. Albumen contained in a reddish stain, with an ash from the same giving reactions for iron, was considered indicative of blood. These tests being successfully made, attention was given to various means by which it was attempted to prove that the stains were *not* made by a large number of substances, which, under certain conditions, have some resemblance to dried blood. Tests of this character are now practically abandoned, and the only properties of blood which constitute the basis of chemical tests are those possessed by the coloring matter in producing a peculiar blue color with tincture of guaiacum under precise conditions, and in the formation of minute crystals of hæmatin hydrochloride, commonly called hæmin. These reactions are called respectively the *guaiacum test* and the *hæmin test.* Both tests are very sensitive, and are capable of application to the very smallest visible particle of material. The hæmin test is absolutely conclusive as to the presence of blood, but the guaiacum test is only confirmatory. A very large number of substances besides blood produce a blue color with guaiacum, so that the test is, by many, held to be of but slight account. The guaiacum test, however, has its value, because if a suspected stain fails to give a blue color it is very strong evidence of the *absence* of blood, or, if originally blood, that it has become so altered by some means (as by boiling water or the action of chemicals) that it will probably fail when attempts are made to test it in other ways.

The two tests are the complements of each other. The hæmin test is conclusive of the *presence* of blood, and the failure to obtain the guaiacum reaction is, for all practical purposes, conclusive of its *absence.*

The Guaiacum Test.—The guaiacum test for blood was first suggested by Van Deem, a Dutch chemist, but it attracted little attention until 1863, when it was studied by Liman (Casper's *Vierteljahrschrift,* 1863, p. 193), and later by Day in 1867 (*Australian Medical Journal,* 1867). Shortly after, the test was made the subject of a critical examination by Taylor, who highly commended it. (*Guy's Hospital Reports,* third series, 1867, vol. xiii., p. 431.) The subject was still further investigated by Lefort in 1870. (*Annales de Hygiene,* second series, vol. xxxiv., p. 429.)

The test is very simple, and requires but a moment for its application. It is made as follows: To an aqueous extract from a suspected stain is added a few drops of tincture of guaiacum. The resin is at once precipitated, and produces a milk-white opacity in the liquid. With blood alone there is no development of color, but on the addition of a small quantity of hydrogen peroxide the milky appearance changes to a beautiful blue. If the stain is old and does not yield any color to water, the test may be applied directly to the stain itself. A drop of water is placed upon the stain, and afterward the tincture of guaiacum, which is immediately followed by the addition of the peroxide. The stain, if blood, gives at once the peculiar blue coloration. If the stain is upon a dark surface, the developed color may be readily observed, as suggested by Taylor, if a small piece of white filter-paper be pressed upon the spot while it is still wet with the reagents. The blue liquid is absorbed and colors the paper. Several impressions may thus be taken from a single stain. In the case of very small stains they may be moistened with water and some of the coloring matter absorbed by pressing upon the stain with filter-paper. The test may then be applied to the impression

upon the paper instead of directly to the stain. It is essential in all cases to add the guaiacum before the peroxide. In some cases a blue color may appear before the addition of the latter; if this occurs, the blood, if present, is mixed with some foreign substance. Blood alone does not color the guaiacum. The test depends upon the production of a blue color *after* the addition of the peroxide, and not before. Should the guaiacum become blue when added to the stain, the conditions are such as make the test valueless. If the blue color be not produced by the guaiacum, but appears on the addition of the peroxide, there is established a *probability* of the presence of blood which must be confirmed by other tests. If the reddish stain produces no blue color under this test, *blood is absent*, unless the stain has been washed with hot water or there has been applied some chemical agent which makes the test inoperative. The guaiacum test is so delicate that one drop of blood in six fluid ounces of water may readily be detected in one or two drachms of the mixture. (Taylor.)

The writer has frequently made the test with a solution containing no more than one drop of blood in four thousand parts of water. If the experiment be made upon the white surface of a porcelain capsule, the blue color may be observed in still greater dilutions. Taylor in 1867 obtained the guaiacum reaction from blood-stains upon a towel which had been in his possession for ten years. Twelve years afterward the stains were again examined, and it was found that while the tincture of guaiacum alone produced no effect, the addition of hydrogen peroxide still developed the blue coloration.

The writer has never failed to obtain the characteristic color produced by this test from blood-stains not more than three years old, but from stains of greater age he has obtained unsatisfactory results.

In 1881 a murder was committed near Springfield, Mass. The dead body of a man killed by a pistol-bullet was found seated in a carriage, the horse being tied to a tree, in a lonely place in the woods. The deceased was known to have had a considerable sum of money in his possession, but when the body was found both the money and a valuable watch were missing. Suspicion was immediately directed to one Loomis, who had been in the company of the murdered man on the previous afternoon, but there could, at first, be found but little evidence to incriminate him. A little more than a year after the affair, a watch wrapped in a handkerchief and inclosed in a buckskin glove was found under some rubbish near the place where the horse was tied. The watch was identified as one which had been the property of the victim, and the glove and handkerchief were proved to belong to the suspected party. The glove and handkerchief were placed in the hands of the writer by the attorney-general, to be examined in regard to the nature of several suspicious stains. These under the microscope showed blood-corpuscles, and gave satisfactory tests, both by guaiacum and the process for obtaining hæmin crystals. Upon this new evidence Loomis was convicted and executed. Twelve years later, during the preparation of the present article, the guaiacum test was again tried upon the stains still showing upon the glove and handkerchief, but no blue color could be produced nor hæmin crystals obtained.

Wormley states that this test will react with very old stains, and even in cases where they have been washed. No doubt the length of time

during which the guaiacum test may be successful varies according to circumstances not fully understood. It is improbable, however, that the examination, in any important case, will be delayed until the blood is so old that the test fails. The guaiacum reaction is of value only as a corroborative test, or as an indication of the probable absence of blood. It is a test which merely demonstrates a single property of this fluid, that of decomposing hydrogen peroxide, and any substance capable of producing this decomposition will develop the blue color. These substances are not very numerous; neither of them has a red color, nor can they possibly be mistaken for blood. The tincture of guaiacum is, *without any addition of peroxide*, turned blue by a considerable number of substances. A list of these is here given. Some of the bodies named produce the blue color only under certain conditions, and not in all cases.

Substances which produce a blue color with tincture of guaiacum, but without the addition of hydrogen peroxide.

Inorganic.	*Organic.*
All oxidizing agents.	Gluten.
Solution of chlorin.	Flour paste (if unboiled).
Hypochlorites.	The fresh juice of
Permanganates.	Potato,
Ferric chloride.	Carrot,
Mercuric chloride.	Onion,
Gold chloride.	Horse-radish,
Nitrous ether.	Dandelion,
Iron peroxide.	Chicory,
Manganese dioxide.	Burdock,
Platinum black.	Sorrel,
	Cherries,
	Currants, mushrooms, and many other fungi.
	Milk.
	All of these substances lose their property of producing the blue color if dried or heated to 212° F.

Nasal mucus, pus, bile, saliva, and sweat-stains produce the guaiacum reaction under the same conditions as blood, but they have no red color and cannot be mistaken for it.

In making the guaiacum test for blood carefully observe the following:

(1) Use only the *freshly prepared tincture.* It should be made as required by dissolving two or three pieces of the resin of the size of a pea in a fluid ounce of alcohol. Do not use a strong solution. The tincture should not be deeper in color than pale sherry wine.

(2) Apply the tincture of guaiacum to the material which is being tested *before* adding the peroxide. It is the failure to produce a blue color with the guaiacum singly and its subsequent development by the peroxide which distinguishes blood from the substances named in the list.

(3) The blue color must appear *immediately*, otherwise no reliance can be placed upon the test. A thin film of guaiacum resin obtained by the evaporation of the tincture upon the surface of cloth or paper will become blue by the action of the air alone after a few hours' exposure.

(4) The test should be applied to an unstained portion of the material which is under examination previous to its application to the stain. Bibulous paper, if used, must be tested in the same manner.

Under the conditions we have given the guaiacum test is reliable and certain. Taylor, as the result of experiments made with a large number of substances, including cochineal, red wine, red ink, extract of rose petals, kino, catechu, Brazil-wood, etc., states that "no red coloring matter, animal or vegetable, excepting the red of blood, produces the blue coloration of guaiacum in presence of peroxide of hydrogen."

(Taylor, *Guy's Hospital Reports*, third series, 1867, vol. xiii., p. 431.)

(Lefort, *Annales de Hygiene*, second series, vol. xxxiv., p. 429.)

(Clement, *Conferences Pratiques sur Médecine Legale*, Paris, 1880.)

The Hæmin Test.—To make this test a drop of blood solution is taken up by the end of a glass rod and spread upon a microscope-slide, so as to give it an extended surface. The slide may be set aside in a place free from dust and allowed to evaporate spontaneously, or it may be heated very carefully in the flame of a spirit-lamp, the slide being moved to and fro, so that the liquid will not be raised to a temperature of more than twenty or thirty degrees above the natural heat of the body. The warmth may be ascertained from time to time by applying the slide to the back of the hand. The temperature must not be allowed to reach 140° F., the point at which albumen coagulates. Should the coagulation take place, the test is likely to fail. Some writers recommend the addition of a particle of common salt to the solution during the evaporation. This is unnecessary in the case of fresh blood, because it contains a sufficient amount of this substance as a natural constituent; but with old or dried blood it is absolutely necessary. The amount required is very small. The best plan is to prepare a solution by weighing out two grains of pure sodium chloride and dissolving in eight fluid ounces of distilled water. A drop of this solution is quite sufficient for the test, and is placed upon the center of the film of evaporated blood. The drop is spread over the film so as to cover all parts of it, and dried off with the same precautions as at first. A drop of glacial acetic acid is next added to the film, the latter covered with a thin glass and the slide heated—this time to a sufficient degree to produce a slight ebullition. There is no longer any danger of the coagulation of the albumen. If the boiling be too rapid, the cover may be violently projected from the slide by the force of the vapor.

If the blood to be tested is in a dried state so that a small particle may be detached, a minute portion is placed in the center of the slide and warmed with a drop of acetic acid. The acid is evaporated and the residue treated with the salt solution, and afterward with a fresh portion of acid, as previously described. In the case of fresh blood a single heating with the acetic acid is sufficient, but with very old blood it is frequently necessary to add the acetic acid a second time and heat it anew. When the acid has wholly evaporated the slide is examined in the microscope under a power of three hundred or four hundred diameters. The operation is easy, but it requires a certain degree of skill in manipulation. The attempt to obtain Teichmann's crystals will often fail in unskillful hands. The principal causes of failure are the coagulation of the albumen and an excess of salt. Coagulation retards the solvent action of the acetic acid, and during the prolonged ebullition

required under such circumstances the salt may be entirely decomposed, and the evolved hydrochloric acid necessary for the formation of the crystals (hæmatin hydrochloride) is expelled before it can enter into combination. *The acid employed must be in its highest state of concentration* —the so-called glacial acid. Acid of lower strength fails to decompose the salt. If too much salt be employed the experiment fails, and the slide shows only a mass of crystals of sodium chloride. *Distilled water must be used.* Ordinary water leaves a residue of organic matter and mineral salts—in some cases very considerable in amount—which interfere with the development of the crystals or may produce a crystalline deposit by itself.

Hæmin crystals are minute flat rhomboids. In many cases they lie superimposed in the form of an X or cross. They vary in color, according to their thickness, from a clear yellow to a reddish brown. They exhibit considerable variation in size, according to the amount of hæmin present and the rapidity of the evaporation. The smallest may be no more than 1–6000 of an inch in length, and the largest may reach 1–1200. The crystals obtained as the result of the test may be covered with thin glass and mounted in the usual manner of microscopic objects. Specimens should be preserved as evidence. Teichmann's crystals once seen can scarcely be confounded with any others. Only two substances have been suggested which resemble them—indigotin and murexide. These, it is claimed, may possibly be produced by a solution of the coloring matter of a fabric dyed with indigo or with ammonium purpurate. Crystals of indigotin are blue, and those of murexide are purplish red and appear green by reflected light.

The hæmin reaction is very delicate. A quantity of dried blood so small as 1–500 of a grain may easily be detected, and with care 1–1000 will give decisive results. (Wormley.)

Time or atmospheric changes, as a general rule, have no effect upon the certainty of the results, provided there be left in the stain a trace of blood-coloring matter.

Fig. 15. Hæmin Crystals. (450 diameters.)

The celebrated political writer Kotzebue was murdered by an enthusiast named Sand in 1819. He was assassinated in his own house, and the papers upon his desk were stained with his blood. Sixty years afterward, in 1879, some of these stains were submitted to the hæmin test and the crystals readily obtained. (Clement.)

Buchner and Simon detected hæmin in a portion of cloth cut from a butcher's slaughtering-trousers which had been eight years in use, and had not been worn for a year and a half previously. (Casper.)

All authorities agree as to the value and reliability of the hæmin test. Clement asserts that "crystals of hæmin are a certain indication of the presence of blood." A report of a commission appointed by the French Medico-Legal Society declared that "these crystals are so perfectly characteristic, that, should they be found, one may positively assert the presence of blood." (Miahle, Mayet, Lefort, and Cornil, *Annales de Hygiene*, 1873, vol. xl.)

Wormley says, "Their production is characteristic of blood, there being no other substance known from which they may be produced." (*Microchemistry of Poisons*, second edition.)

Failures to obtain hæmin crystals may occur even under the most expert manipulation in the case of old washed stains, but it is the experience of the writer that a stain which under proper treatment fails to yield crystals will fail also to give absorption-bands in the microspectroscope, although fragments of corpuscles may still possibly be found under microscopical examination. In brief, crystals of hæmin, if found, furnish conclusive evidence of the presence of blood. Failure to obtain them is not conclusive as to its absence.

(Erdmann, *Jour. de Phar. et de Chimie*, vol. xli., p. 33.)
(Blondlot, *Annales de Hygiene*, 1868, vol. xxix., p. 130.)
(Clement, *Conferences Pratiques de Médecine Legale*, Paris, 1880.)
(Otto, *Der Gifte und Blutflecken*, Braunsweig, 1875, p. 162.)
(Wormley, *Microchemistry of Poisons*, second edition, Philadelphia, 1885.)

THE PRACTICAL TESTING OF BLOOD-STAINS IN THE MICROSPECTROSCOPE.

Different modes of procedure are required in preparing specimens for spectroscopic examination, according to the age of the stain and the amount of material available for the purpose. If the stain be comparatively recent the operation is simple, easily conducted, and absolutely conclusive in its results. In older stains the conclusions reached are reliable when obtained, but specimens require a more complicated treatment.

1. *Examination of a Recent Stain.*—If the stain is upon cloth, a portion of the fabric with the stain (one-half inch to one inch square, if possible) is cut into small strips and macerated with distilled water. This is best done in small tube-vials holding from one eighth to one fourth of a fluid ounce. Glass stoppers are preferable, but good sound corks may be used for keeping the specimens free from dust. Each vial should be carefully labeled. If a clot can be obtained free from adhering tissue, it may be treated in the same manner. The amount of water should be proportioned to the size of the clot or stain, and such as to yield a reddish or reddish-brown solution of moderate intensity of color. When the water has become colored, which will be the case in from fifteen minutes to an hour, a portion is removed by a capillary pipette made by heating a small glass tube and drawing it out to a point. The vial should be allowed to stand a sufficient time to allow any sediment to deposit, and this should not be disturbed when the liquid is with-

drawn. The fluid taken up by the pipette is transferred to a glass cell made as previously described (Fig. 11), and placed on the stage of the microscope. The cell should be covered by a cap with a small opening in the top to cut off extraneous light, or it may be covered on the outside with black paper. The examination may be made either by sunlight or an artificial source of illumination. It is advisable to try both methods. The microscope with a low-power objective (one-half inch to two inches) is focused upon the top of the cell, and the spectrum is ready for observation. The slit of the spectroscope must be narrowed so as to allow only a sufficient light to pass, the amount necessary depending upon the strength of the solution, the degree of illumination, and the depth of the stratum of liquid. Under favorable conditions, the two bands of oxy-hæmoglobin will make their appearance, while the blue end of the spectrum will be more or less obscured. In many cases the spectrum will appear like that of No. 4 or No. 5 in Pl. V. This shows that the stain is of greater age (met-hæmoglobin) than if the spectrum is like No. 1. In either case, drop into the cell a minute crystal of ferrous ammonium sulphate (a particle not larger than the head of a small pin), and immediately about the same amount of sodio-potassium tartrate (Rochelle salt). Stir the solution with a platinum wire until both salts are dissolved; next add a drop or two of ammonia water, and stir once more. The spectrum, if originally that of oxy-hæmoglobin (Pl. V., No. 1), will now change to that of reduced hæmoglobin (No. 2). In case the spectrum originally presented the appearance of No. 4 or No. 5, it will under the action of the added reagents change to that of No. 6 (reduced hæmatin).

If the first spectrum was like No. 1 (oxy-hæmoglobin), a fresh portion of the solution may be tested as follows: To the blood solution in the tube a little citric acid is added, when, if the color be sufficiently intense, a spectrum more or less resembling No. 3 will develop. In most cases the band at the extreme right is not produced, and it frequently happens in dilute solutions that neither of the other bands makes its appearance; but even in this case the addition of the iron salt, etc., and ammonia water until the acid is neutralized will give the spectrum No. 6 (reduced hæmatin).

A blood-stain no larger than one-eighth inch square will show these bands in a satisfactory manner, provided that all the conditions are carefully observed. If the solution be very strong in color, a thinner stratum may be examined or the intensity of the light increased. Sorby remarks that if all the characteristic results here given are obtained, "no one can hesitate in giving evidence that the mark is blood."

2. *Examination of Older Stains.*—As we have already observed, oxy-hæmoglobin becomes gradually converted into hæmatin, and when this change is complete the coloring matter is wholly insoluble in pure water. For such cases, therefore, a different procedure is necessary. If the particles or portions of fabric in the macerating vial do not readily yield their color to water, a few drops of acetic or a grain or two of citric acid may be added, and the bottle with its contents allowed to stand in a moderately warm place for several hours, or longer, if necessary. The solution is examined in the same manner as before, but the absorption-bands produced will be those of acid hæmatin (No. 3). The iron salt, etc., and ammonia may next be added to the liquid in the tube-cell, as

in the former tests, with the effect of developing the spectrum of reduced hæmatin (No. 6).

Sorby states that he has been able to discover hæmatin by the micro-spectroscope in a stain forty-four years old. Tidy obtained excellent spectra from stains on a garment preserved by the relatives of an officer who died in battle in 1771, and consequently more than a hundred years old.

Letheby, from a portion of a fabric one-fourth inch square, having upon it a blood-stain seventeen years old, and which had been completely changed to hæmatin, obtained as well marked spectra as from comparatively recent blood. (*London Hospital Reports*, vol. iii., p. 41.) Richardson, in a stain five months old, obtained satisfactory tests by the micro-spectroscope from a portion one fiftieth of an inch in diameter.

If there is reason to believe that stains have been washed with hot water or heated, whereby the albumen becomes insoluble, it will be necessary to use ammonia water to dissolve the coloring matter, as dilute acids under these circumstances have very little action. If a blood-stained fabric has been washed, only a slight discoloration may be observed, but it will be spread over a greater surface. In such a case cut the stained portion into small pieces and macerate with a little ammonia water, the tube-vials being set aside for several days in a warm place. Should the solution thus obtained be of too faint color, it must be concentrated by evaporation on the water-bath, care being taken that the liquid is kept alkaline during the process by the addition, from time to time, of small additional quantities of ammonia.

The spectrum of alkaline hæmatin may possibly be obtained from this solution, but, in any case, the test should be made for reduced hæmatin as in the previous trials. When the stain is upon a dyed fabric, the addition of ammonia may cause the solution of more or less of the dye color. In such a case tests with the spectroscope are not very satisfactory, as the dye color may completely mask the absorption-bands of blood. Sodium bisulphite will generally bleach these colors, while the coloring matter of the blood is not affected. Citric acid acts less upon a dyed fabric than ammonia, and should be used if possible. Stains upon oak-wood or leather are difficult of detection by the spectroscope, owing to the action of the tannin upon the blood-coloring matter, whereby it is rendered insoluble and not easily converted into a form capable of satisfactory examination. A trial, however, should always be made, even upon this sort of stain.

Spectroscopic tests may be obtained from the red blood of all animals. "Oxy-hæmoglobin from any source is universally the same in its spectroscopic properties, the compounds it forms, and the products of its decomposition, hæmatin, hæmin, etc." (Halliburton.)

SPECTRA OF COLORED SUBSTANCES SOMEWHAT RESEMBLING BLOOD.

Under the action of ammonia, citric acid, and salts of iron, as previously described, stains due to blood may be absolutely distinguished from all other red coloring matters. Quite a number of these colors give absorption-bands which resemble those of oxy-hæmoglobin, but their appearance under the action of reagents is wholly different.

Cochineal and Ammoniated Carmine.—These give absorption-bands somewhat like those of blood (Pl. V., No. 7), but on the addition of boric hydrate (boracic acid) the bands change their position to the blue end of the spectrum. The position of the bands produced by blood is, under the same treatment, unchanged.

Lac-dye, madder-red, alkanet root, and the petals of red-leaved plants, as *cineraria,* give spectra somewhat similar to those of blood, but they are seen to be distinctly different when the two spectra are observed side by side. These colors are all bleached by the action of sodium bisulphite. These substances, and all other red colors, says Wormley, "differ from blood in most instances in the position and character of the spectral bands, and in all cases in the effect of reagents upon them. At the present time there is no substance known that in all these respects is similar to the coloring matter of blood."

(Wormley, *Microchemistry of Poisons,* second edition, Philadelphia, 1885, p. 721.)

(Sorby, *Quarterly Journal of Science,* London, 1865, vol. vi., p. 9; also *Chemical News,* London, 1865, vol. xi., pp. 186, 194, 232, 256.)

(Woodman and Tidy, *Forensic Medicine,* Philadelphia, 1877, p. 515.)

(Tidy, *Legal Medicine,* Philadelphia, 1882.)

THE MICROSCOPICAL EXAMINATION OF BLOOD-STAINS.

The microscopical examination of blood when fresh and still fluid presents no difficulties. The formation of a very thin layer obtained by spreading a drop upon a microscope-slide by rapidly drawing over it the edge of a cover-glass slightly inclined is all the preparation necessary. Such a specimen examined in the microscope under a good one-fourth or one-fifth objective will show hundreds of red corpuscles, and probably several colorless ones.

The suspected blood-stains which are submitted to the microscopist for examination in criminal trials are almost invariably in a dried state. The precise conditions under which they have been produced, their age, and the various agents or influences (heat, moisture, etc.) to which they have been subjected, are generally unknown. The blood must necessarily be removed from the material to which it adheres or into which it has penetrated before it can be examined in the microscope, and this must be done by, and the specimen prepared in, an artificial serum entirely different from the fluid in which the corpuscles are found in their normal state. Moreover, in most cases, the greater number of these bodies in drying become distorted, shriveled, and greatly reduced in volume. Water or other agents may have been applied to the stains, by which the texture of the corpuscles becomes so far altered that they are no longer recognizable. These are some of the conditions under which the microscopical examination must be undertaken, and it is not surprising that it sometimes fails even when other tests have demonstrated the presence of blood. Blood-corpuscles once entirely deformed by decomposition cannot be restored by any known reagent. On the other hand, when the blood has rapidly dried upon a non-absorbent surface, or where it has formed a clot which has not been subjected to disturbing agencies, the conditions are favorable for the discovery of

some of the corpuscles, and for determining whether they are mammalian or oviparous.

A blood-clot consists of a mass of corpuscles imbedded in and held together by fibrin and albumen, which, on drying, form a strong cementing material. In this condition no corpuscles can be distinguished, so that to prepare a specimen for examination in the microscope it is necessary to dissolve the albumen in order that these bodies may, if possible, separate from the clot, or that the clot itself be made sufficiently transparent for the outlines of the corpuscles to become visible. This is attempted by soaking the clot or stain in a liquid so constituted that it can dissolve or soften albumen while having little or no action upon the corpuscles. A large number of fluids for this purpose have been proposed. A very complete list, with formulas for their preparation, is given by Formad in his article on mammalian blood contained in the *Journal of Comparative Medicine and Surgery*, 1888, vol. ix., p. 289. Another collection of formulas, by Masson, may be found in the *Annales de Hygiene*, 1885, third series, vol. xiii., p. 393.

The best of these preparations are the following:

I. Virchow's Solution of Potassium Hydrate.

Potassium hydrate	33 parts.
Water	100 "

(33-percent. solution.)

II. Richardson's Salt Solution.

Sodium chloride	3 parts.
Water	400 "

($\frac{3}{4}$-percent. solution.)

III. Welcker's Glycerin Solution.

Pure concentrated glycerin	1 part.
Water	7 parts.

(The solution to be diluted to S. G. 1.028.)

IV. Vibert's Fluid.

Mercury bichloride	1 part.
Sodium chloride	4 parts.
Water	200 "

Virchow's preparation acts with greater rapidity than the others, and gives, in most cases, excellent results. It is not desirable to employ it, however, in treating very old stains, which require a prolonged soaking, as it gradually destroys the corpuscles. With stains which require longer treatment Richardson's solution appears to be open to the least objection. Diluted glycerin is highly praised by many observers, and is very satisfactory in its operation. It has the advantage of evaporating less rapidly than fluids containing only water as a menstruum. It is always advisable to make several preparations of each specimen examined, using a different fluid in each case. It very often happens that stains give results with some one of the preparations which are not obtained with the others. The examination of a clot, however minute, is much more satisfactory than that of a stain upon a fabric or porous surface. Such a specimen should be selected, if possible. To prepare it, a small particle is placed upon a thin cover-glass, which, after the addition of a drop or two of either of the above-mentioned fluids, is inverted over a concaved slide. The edges of the cover should be sealed with paraffin or mounting-varnish to prevent evaporation. The slide may be set aside for a few hours, or may be at once examined as the action of the fluid progresses. Scrapings from a stain, if no clot is procurable, may be treated in the same manner; or a small portion of the

stained fabric may be moistened upon the slide and the fibers separated by picking apart with needles.

If the stain or clot be tolerably recent the corpuscles may begin to show themselves in a few minutes. With older stains the process may require several hours, or even days. Stains which are more than a week old act, under the operation of the solvent, in substantially the same manner as stains which are much older, and there is practically no difference, in most cases, between stains of a month's age and those of a year's standing, provided the specimens have been kept under conditions which have not affected the structure of the corpuscles.

In specimens under examination the portions of fluid immediately surrounding each particle become gradually tinted of a reddish or orange-yellow color from the solution of the blood-coloring matter, and when the decolorization is nearly complete the corpuscles begin to be visible. Very few perfect ones may be found, because most of them have become broken or distorted while drying. If, however, the drying has taken place under favorable conditions, if the stain has not been washed, subjected to heat or prolonged dampness, we may by searching almost always discover a few well-preserved corpuscles. If, under the treatment we have given, the characteristic disks make their appearance, there can be no question as to the character of the stain, *but the observer must be certain that the cell-like structures which develop really are corpuscles.* Serious mistakes have many times occurred where objects have been discovered which, under preconceived notions of the observer, have been pronounced corpuscles of blood.

The following remarkable case is within the personal knowledge of the writer:

In the case of *Commonwealth* vs. *Piper*, tried in Boston in 1875, the defendant, a sexton, was charged with the murder of a child in the belfry of his church. Certain articles having upon them suspicious stains were placed in the hands of several local experts for examination. Among the specimens was about a half-pint of water found in a pitcher in the basement, in which it was thought that the prisoner had washed his bloody hands. A short time previous to the trial, the experts, four in number, made their report of the results of their examination to the prosecuting officers, and every one of the four stated that the water contained blood-corpuscles which measured on the average about 1–3300 of an inch in diameter. This evidence was not given at the trial, because the government decided not to introduce any testimony in relation to blood, but the results stated in the report would undoubtedly have been given if it had been called for. A portion of the water was critically examined by Professor Wormley, and the bodies which had been confidently measured as corpuscles were proved to be merely the *spores of a confervoid alga.*

In the case of *State of Connecticut* vs. *Hayden*, tried at New Haven a few years since, a stone was produced at the preliminary trial which had been found in a field near the spot where a young woman had been murdered, and it was the theory of the prosecution that it had been used for striking a blow upon the head of the victim. The stone was stained with what appeared to be blood, and it was testified by a medical witness of some local celebrity that a microscopical examination demonstrated its presence. Subsequently, in preparation for the regular trial, the stone

was examined by another expert, and it was shown, and acknowledged by the first witness, that a mistake had occurred, and that *spores* had been taken for corpuscles.

The following case is given by Erdmann. (*Zeitschrift fur Analyt. Chemie,* vol. ii., 1862.) An assassination had been committed in Leipzig, and there was found near the spot where the crime had been perpetrated a brownish stain, which, under the influence of rain, assumed the appearance of coagulated blood. An aqueous solution of this stain furnished a reddish fluid, which gave with tannin, potassium ferrocyanide, and other reagents the same reactions as a solution of dried blood. Examined under the microscope, the brown matter was found to contain corpuscles similar to those of blood. The stain, however, failed to give any hæmin crystals when this test was applied, and this caused Erdmann to entertain doubts as to the value of the other tests. He repeated the microscopical examination with greater care, and then discovered that the bodies supposed to be blood-corpuscles were the spores of an alga, probably *porphyridium cruentum*, a vegetation so named on account of its resemblance to blood.

The disks found in pine, spruce, cedar, and other coniferous woods, the excrements of the cimex, spheroidal crystals of ammonium urate, oil-globules, air-bubbles, etc., are mentioned by writers as possible causes of error in suspected stains, but no microscopist of experience can possibly mistake any of them for blood-disks. The only dangerous fallacies are to be found in bacteria and spores. Bacteria are very much smaller than blood-corpuscles. The micrococcus known as *prodigiosus*, which in masses appears to the naked eye like fresh blood, has not one tenth the diameter of a blood-disk. But there are spores of various fungi and algæ which in many instances have the same diameter as blood-corpuscles. The spores of *porphyridium* mentioned in Erdmann's case measure from 1–2900 to 1–3700 of an inch in diameter. (Rabenhorst.) Some of the fluids which have been recommended by certain writers for soaking out the corpuscles from blood-clots, particularly sodium sulphate, sodium phosphate, and glycerin solution, if too much diluted will, in a few days, if kept in a warm place, develop spores some of which closely resemble decolorized blood-corpuscles.

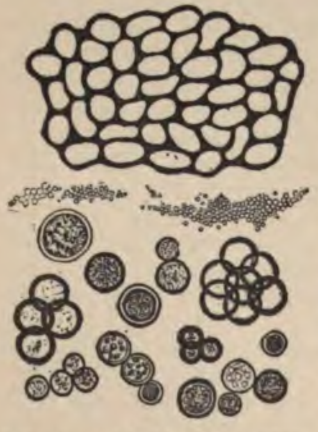


Fig. 16. Blood-clot and Various Spores. (750 diameters.)

Richardson, referring to a preparation recommended by several writers, a saturated solution of sodium sulphate, says: "It must, I think, owe its popularity chiefly to the fact that it contains large quantities of fungus, the spores of which resemble blood-corpuscles both in size and general appearance, and have, I have no doubt, frequently been mistaken for blood-cells." (*Amer. Jour. Med. Sciences,* vol. lxviii., p. 109.)

Under the action of water, blood-corpuscles become globular and finally transparent and invisible, but spores are not in any way changed in appearance under the same circumstances. Spores are never disk-shaped, though they often

appear so. They are frequently oval and often circular; they may have buds upon them, and they are generally found in groups of two, three, or more. Close examination will, in many cases, show an interior structure wholly different from a blood-corpuscle. That they are a dangerous source of fallacy is proved by the instances we have given, and the observer should make it a rule to first microscopically examine the preparation with which he intends to soak up a suspected stain, and use only fresh or recently made solutions.

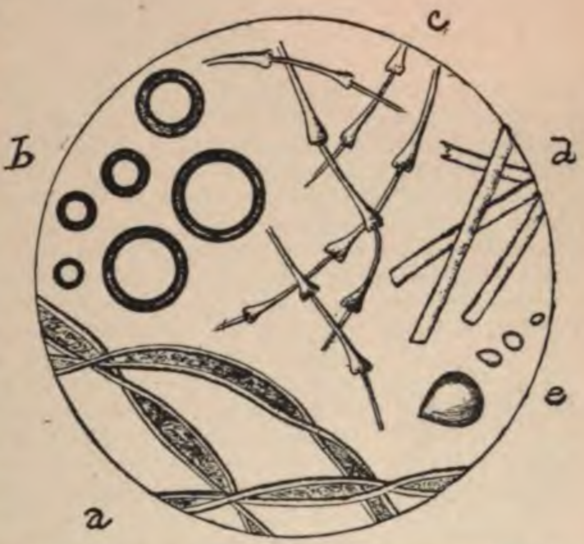


Fig. 17. *a*, Cotton Fiber; *b*, Air Bubbles; *c*, Portions of Feather; *d*, Silk; *e*, Oil Globules. (After Hofmann; 300 diameters.)

Materials found Associated with Blood.—Incidentally to the microscopic examination of suspected stains in the search for blood-corpuscles, other bodies may be discovered, of which careful note should be made. These may be one or more of the following: *fibers of silk, wool, cotton, or linen; fragments of mineral substances, as sand, earth, bits of metal, etc.; hairs of various kinds, barbules of feathers, vegetable tissues, grass, wood, etc.; particles of bone, muscular fiber, cerebral matter, epithelium, etc.* All such substances should be carefully preserved. They may furnish important evidence as to locality or circumstances. The limits of this article do not permit the discussion of the means of identification of these bodies, and the reader is referred to any good work on the microscope, as the treatises of Carpenter, Frey, Beale, and others.

MEASUREMENT OF BLOOD-CORPUSCLES.

If blood-corpuscles are found by the microscopic examination, it will be necessary to measure them. There are several methods by which this may be accomplished:

(1) By the screw micrometer.
(2) By photography.
(3) By the eye-piece micrometer.

The last is the most common as well as the most convenient method, and is the only one which we shall describe. The eye-piece micrometer in its simplest form consists of a circular glass plate ruled with fine lines (Fig. 17, B), which is cemented upon the diaphragm of the eye-piece between the field-glass and the ocular lens. The best arrangement

is that of a thin brass slide holding the ruled glass, which is inserted through a slit in the side of the eye-piece and has at one end a screw by which the micrometer can be given a slight lateral motion. The object to be measured is observed through the glass micrometer; one side of the object to be measured is brought exactly up to one of the lines, and the number of spaces which the object covers is carefully counted.

The value of the spaces of the eye-piece micrometer is merely relative, and dependent upon different objectives and varying adjustments of the instrument. The value of the spaces is determined by a stage micrometer. This consists of a piece of ruled glass with spaces of 1–1000 of an inch. These spaces, when magnified and seen through the eye-piece micrometer, are covered by a certain number of lines in the latter. With a given objective, a 1–1000 space, for example, may be magnified until it covers five lines in the eye-piece; one of the latter spaces, therefore, measures 1–5000 of an inch. In most cases the eye-piece micrometer will not cover any certain number of *full* spaces, but there will be so many spaces and a fractional part of another space.

In such cases the draw-tube of the instrument must be extended until the increased amplification makes the space of the stage micrometer equal to a number of full spaces in the eye-piece. For convenience of calculation the number of these should, if possible, be some multiple of five or ten. If, under a high power (2500 diameters), forty spaces in the eye-piece are required to cover one space (1–1000 inch) of the stage micrometer, one space of the former will indicate 1–40,000 of an inch. Fig. 18, A, represents a portion of an eye-piece micrometer under a micrometry of 40,000, and the concentric circles the outlines of blood-corpuscles of man, the dog, rabbit, ox, and sheep. The largest corpuscle covers $12\frac{1}{3}$ spaces; its measurement is therefore 12.33–40,000 of an inch. Reducing this fraction to its simplest form, we obtain 1–3244. In the same manner we find that the corpuscle of the sheep covers $7\frac{3}{4}$ spaces, and therefore measures 7.75–40,000, which equals 1–5161.

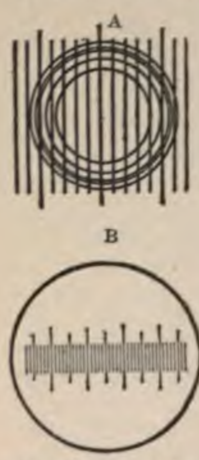


Fig. 18. Eye-piece Micrometer.

We cannot enter further into the minute details of micrometry, but must not omit a single most important suggestion. No perfect stage micrometer was ever produced, and the observer must carefully compare and calculate the true value of each space which forms the basis of his measurements. An otherwise valuable piece of testimony may be completely shattered by a single question on cross-examination: "If you have not verified your micrometer, how do you know that your measurements are correct?"

THE DISTINCTION BETWEEN HUMAN AND OTHER BLOOD.

It is only by the microscope that any satisfactory distinction can be made between human and other blood. Various methods have been suggested depending upon other principles, but they have been found to be unreliable or impracticable in their application to dried stains. Barruel's process depends upon the production of an odor characteristic

of the particular animal when fresh blood is mixed with sulphuric acid. (*Annales de Hygiene*, 1829.) Taddei proposed to distinguish human blood from that of animals by the degree of fluidity produced in a compound of blood and carbonate of copper when treated with sulphuric acid. (For an account of Taddei's process, called hæmatolloscopy, and also Barruel's method, see Fleming's article on blood-stains in *Am. Jour. Med. Sciences*, vol. xxxv., p. 98, 1859.) Neumann claims that blood evaporated at a temperature of 60° F. gives a residue exhibiting certain appearances called "blood pictures," which are characteristic of different animals. (*Die Erkennung des Blutes*, Leipzig, 1869.)

There are two marked points of difference, under microscopic examination, between mammalian and oviparous blood: 1. The circular outline of the corpuscles of the former, in contradistinction to the oval shape of the latter; 2. The presence of a nucleus in oviparous, and its absence in mammalian, blood. Whether the stain be fresh or dry, recent or very old, these differences are apparent and unmistakable. Many instances have occurred in murder trials in which the defendant has claimed that stains on his clothing were produced by the killing of a fowl or were due to the blood of fishes. In all such cases, the falsehood, if it be one, is easily proved.

The possibility of distinction between the blood of man and the other mammalia has been claimed by several eminent authorities, including Schmidt, Richardson, Formad, Wormley, and Reese, and strenuously denied by others, especially by Woodward and Ewell. Nearly all writers on medical jurisprudence express grave doubts as to the value of opinions based upon variable fractional differences obtained by comparative measurements of corpuscles derived from dried stains.

The blood-corpuscles of most of the mammalia are smaller than those of man, so that when human blood is compared with that of the ox, for example, each being in a fresh state, by examining the specimens side by side upon the same slide (for an account of Richardson's method of preparing such slides, see *American Naturalist*, May, 1876) a difference in the diameters of the two is, even to the most careless observer, clear and unmistakable.

The diameters of the corpuscles of a large number of animals have been measured and their averages recorded. Suppose now that a specimen of mammalian blood of unknown origin and in a dried state upon cloth is subjected to microscopic examination: within what limits is the observer warranted in expressing his opinion as to its origin?

In answer to this inquiry, we remark that there is no fixed or invariable average for the diameters of the blood-corpuscles of any animal. It is true that the average does not vary beyond certain limits, but these limits have been shown by the observations of Woodward and Ewell upon the corpuscles of man and the dog to be much greater than formerly supposed. Not only is this true, but the averages given by different observers, while agreeing closely in some instances, show considerable differences in others, so that, assuming the principle involved in this method of comparison to be correct, "it entirely depends," as Formad observes, "upon whose figures we accept whether we can or cannot discriminate between human blood and the blood of certain other animals."

The following tables give the average measurements of the blood-corpuscles of man, dog, guinea-pig, rabbit, rat, mouse, opossum, wolf,

ass, pig, ox, cat, horse, sheep, and goat, according to different observers. The figures represent fractions of the inch, and the measurements are of fresh blood dried upon glass.

Man.

Woodward (1876)	1–3092
Ewell (1890)	1–3162
Gulliver (1875)	1–3200
Formad (1888)	1–3200
Richardson (1876)	1–3224
Wormley (1885)	1–3254
Masson (1885)	1–3257
C. Schmidt	1–3267
Malinin (1875)	1–3300
Woodward (1875)	1–3379
Köllicker	1–3390
H. Schmid (1878)	1–3412
Harting	1–3436
Robin	1–3484
Taylor	1–3500
Flint	1–3500

Rabbit.

Gulliver	1–3607
Masson	1–3636
Wormley	1–3653
Formad	1–3662
Schmidt	1–3968

Rat.

Wormley	1–3652
Gulliver	1–3754
Schmidt	1–3968
Schmid	1–5000

Pig.

Schmidt	1–4098
Masson	1–4098
Gulliver	1–4230
Formad	1–4250
Wormley	1–4268

Ox.

Formad	1–4200
Wormley	1–4219
Masson	1–4237
Schmidt	1–4254
Gulliver	1–4267
Welcker	1–4545
Schmid	1–4695

Sheep.

Wormley	1–4912
Formad	1–5000
Welcker	1–5076
Gulliver	1–5300
Schmidt	1–5649
Schmid	1–6060

Dog.

Woodward	1–3246
Gulliver	1–3395
Welcker	1–3485
Wormley	1–3561
Masson	1–3577
Formad	1–3580
C. Schmidt	1–3636
H. Schmid	1–3846

Guinea-pig.

Woodward	1–3213
Masson	1–3300
Formad	1–3400
Gulliver	1–3538

Opossum.

Wormley	1–3145
Gulliver	1–3557

Wolf.

Wormley	1–3422
Formad	1–3450
Gulliver	1–3600

Ass.

Wormley	1–3620
Gulliver	1–4000

Mouse.

Wormley	1–3743
Gulliver	1–3814
Schmidt	1–4000

Cat.

Welcker	1–3922
Wormley	1–4372
Masson	1–4400
Schmidt	1–4545

Horse.

Wormley	1–4243
Formad	1–4310
Schmidt	1–4464
Welcker	1–4545
Gulliver	1–4600

Goat.

Welcker	1–5525
Formad	1–6100
Wormley	1–6189
Gulliver	1–6366
Schmidt	1–6369

The subjoined diagram represents the apparent areas of the corpuscles of these animals (except the ass and wolf) according to the tables. The outside columns represent respectively the *highest* and the *lowest*

average of any observer, while the middle column represents the *averages of the averages*. It is obvious that the blood of some of the common animals cannot be distinguished from that of man *even in a fresh state.*

Formad (*Jour. of Comp. Med.*, 1888, vol. ix., p. 269) attacks the measurements of Woodward, and endeavors to prove that they are erroneous. To this it may be replied that if it be possible that so distinguished a microscopist as Woodward did make an error, it demonstrates that the conclusions drawn from measurements of a less competent observer would be of little value as evidence in a capital trial.

There is no doubt, however, that micrometric measurements *are* liable to error. In order to ascertain the relative accuracy of such determinations made by different competent observers, Ewell ruled a glass slide with fifteen lines, making spaces approximately of 1–250 to 1–125 of an inch, and caused the same to be measured by six well-known microscopists, who were instructed to take *the mean of at least five measurements of each space.* Using standard micrometers by the same maker, the result showed that the measurements of the same space by different observers varied from 0 to 1–9090. This is a greater difference than that between the average diameters of the blood-corpuscles of man and any of the common domestic animals except the sheep and goat, according to all observers. On the other hand, Wormley and two others measured ten lines of the 1–1000 divisions of a stage micrometer, and it was found that they agreed in the several readings within 1–200,000 of an inch.

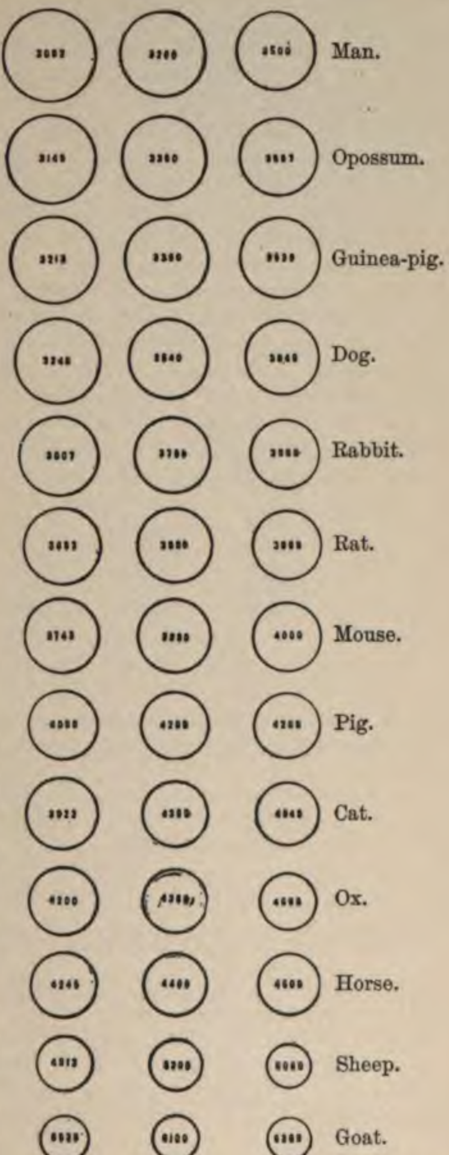


Fig. 19. Diagram representing the Comparative Sizes of the Red Blood-Corpuscles of various Animals. (1450 diameters.)

The uncertainty of discrimination between human blood and that of other mammals does not depend upon possible errors of measurement.

Gulliver, referring to his own extensive measurements of corpuscles, says: "Special circumstances, too, of which we have not yet sufficient knowledge, may affect the value of any series of such measurements as are recorded in these tables. When the bird is much excited and the circulation quickened by attempts at its capture in an aviary, the oval figure of its red blood-corpuscles may be more elongated than in the same bird when quiet or at rest; and my attention was sometimes arrested by like diversions in other vertebrates at different times and seasons, though not in so many observations, and with such notes as would be requisite for satisfactory conclusions. But the facts are sufficient to show that exact and extensive investigations are yet necessary on the comparative magnitude of the red corpuscles and their aggregate proportion to the other parts of the blood at different seasons and under different circumstances. For example: whether minute diversities in the corpuscles may not be found in man at the tropics and at the frigid zones; in animals at rest and during violent exertion; in hibernating animals during summer and winter; in species subject to periodic changes in temperature." (*Proc. Zoolog. Soc. London*, 1875, p. 477.)

Woodward measured 1766 corpuscles in groups of 22 to 140 upon twenty-two photographic negatives taken from the blood of eight persons, and found averages* as follows:

1-2915	1-3049	1-3068	1-3165	1-3215
1-2967	1-3056	1-3068	1-3165	1-3236
1-2985	1-3058	1-3125	1-3175	
1-2994	1-3066	1-3135	1-3185	
1-3022	1-3066	1-3155	1-3205	

General average of 1766 corpuscles, 1-3090.

(*Trans. Am. Med. Assn.*, 1876, vol. xxvii., p. 303.)

In another series of measurements of 651 corpuscles in groups of 50 each Woodward found the averages to be:

1-3289	1-3356	1-3379	1-3425	1-3472
1-3333	1-3367	1-3400	1-3448	
1-3344	1-3367	1-3425	1-3460	

General average, 1-3379.

(*Am. Jour. Med. Sciences*, 1875, vol. lxix., p. 151.)

Ewell obtained the following averages:

Boy (thirty-six hours old),	average of	200	corpuscles	1-2873
Man (plumbism),	"	100	"	1-2950
Man (tuberculosis),	"	100	"	1-3048
Man (gastritis),	"	100	"	1-3067
Man (normal),	"	100	"	1-3162
Man (anæmia),	"	100	"	1-3311

(*North American Practitioner*, 1890, pp. 97, 151.)

In the dog Woodward reports the averages obtained from 1571 corpuscles measured upon thirteen negatives:

* In these and the succeeding values the original decimal measurements have been reduced to the form of vulgar fractions, and the order of statement slightly transposed.

1–2941	1–3226	1–3246	1–3356	1–3379
1–3155	1–3226	1–3279	1–3356	
1–3175	1–3226	1–3322	1–3379	

General average, 1–3246.

(*Trans. Am. Med. Asso.*, 1876, vol. xxvii., p. 303.)

Ewell, in measuring several series of 100 corpuscles from each of three dogs, obtained the following results:

Puppy (eight days old)	1–2985	1–3039	1–3039	1–3125
Puppy (eight weeks old)	1–3333	1–3378	1–3412	
Puppy (seventy-six days old)	1–3257	1–3355	1–3610	

(*North American Practitioner*, pp. 97, 151.)

We are not aware that any extended series of measurements has been made of the corpuscles of other animals covering different ages, breeds, etc., but it is probable that as wide variations exist in all cases as have been proved with man and the dog.

The averages above given are of *fresh* blood rapidly dried upon glass under the most favorable conditions for measurement. In dried blood after attempted restoration, the difficulties of exact measurement and of possible variation are much greater. In a moist atmosphere corpuscles on drying sometimes diminish in diameter to a very marked degree. In the Sturtevant murder case, tried at Plymouth, Mass., in 1874, two medical experts of excellent reputation testified that "in all probability" certain blood-stains were human, because the corpuscles averaged "between 1–5400 and 1–6000 of an inch in diameter," these figures having also been obtained by the witnesses from measurements of their own blood, dried and treated in the same manner as the specimens in evidence.

The question may still be asked, Are there not *limits* in the measurements of blood-corpuscles which, in certain cases, will warrant the expression of opinion as to their origin? Doubtless there are limits, but, in our opinion, these practically exclude all the common animals except the sheep and the goat. There may be instances, under specially favorable circumstances (as spots upon glazed paper, porcelain, or metallic buttons, etc.), in which one may make satisfactory measurements of the corpuscles. Not less than 300 corpuscles should be measured to ascertain the average (Formad says 500). In such cases, if the corpuscles be too large, it can be said with reasonable certainty that the blood is *not* that of some given animal.

Richardson admits that it is practically impossible to determine the difference in dried stains between human blood and the blood of any animal the average measurement of whose corpuscles is more than 1–4000 of an inch. (*Monthly Micros. Jour.*, London, vol. xiii., p. 215.)

The following animals are included under this head, if we accept the *highest average of any observer* as the one on which we base our conclusion:

Elephant	1–2745	(Gulliver)	Wolf	1–3422	(Wormley)
Sloth	1–2865	(Gulliver)	Woodchuck	1–3484	(Gulliver)
Whale	1–3099	(Gulliver)	Hare	1–3560	(Gulliver)
Opossum	1–3145	(Wormley)	Rabbit	1–3607	(Gulliver)
Capybara	1–3164	(Wormley)	Ass	1–3620	(Wormley)
Guinea-pig	1–3213	(Woodward)	Rat	1–3652	(Wormley)
Dog	1–3246	(Woodward)	Bear	1–3656	(Wormley)
Seal	1–3281	(Gulliver)	Mouse	1–3743	(Wormley)

Muskrat	1–3282	(Wormley)	Mule	1–3760	(Wormley)
Beaver	1–3325	(Gulliver)	Bat	1–3880	(Gulliver)
Porcupine	1–3369	(Gulliver)	Cat	1–3922	(Welcker)
Monkey	1–3382	(Wormley)	Raccoon	1–3950	(Wormley)
Kangaroo	1–3410	(Wormley)	Squirrel	1–4000	(Gulliver)

The following expressions of opinion of well-known authorities are of interest:

Gulliver (*Proc. Zoolog. Soc.*, London, 1875, p. 484) says: "The magnitude of the corpuscles in a single species, not excepting the human, is liable to variations within certain limits; and there commonly appear in one field of vision of the same corpuscles differences amounting to at least one third larger and smaller than the average. Hence, as regards the medico-legal question, however truly a careful observer (Dr. Richardson, *Monthly Micros. Jour.*, 1874) may have distinguished, by comparative measurements of the corpuscles, stains of human blood from those of the sheep and ox, this kind of diagnosis would be ineffectual in some probable and more possible cases."

Woodward (*Am. Jour. Med. Sciences*, 1875, p. 151) maintains it to be the duty of the microscopist summoned as a scientific expert to examine a suspected blood-stain to make it clearly understood by both judge and jury "that neither by the microscope nor by other means yet known to science can the expert determine that a given stain is composed of human blood and could not have been derived from any other source. This course is imperatively demanded of him by common honesty, without which scientific experts may become more dangerous to society than the very criminals they are called upon to convict."

Ewell (*Medical Jurisprudence*, Boston, 1887, p. 243) says: "It would be extremely perilous to undertake by mere micrometric measurements alone to distinguish the blood of man from that of another mammal."

Tidy (*Legal Medicine*, vol. i., Philadelphia, 1882) says: "It would, in our judgment, be unwise to hazard an opinion as to the source of a given specimen of blood from the microscopic measurements of the disks, especially considering that, as a rule, where evidence of this kind is needed the measurements have to be made after treating the dried corpuscles with some liquid reagent."

Halliburton (*Chemical Physiology*, London, 1891) remarks as to corpuscles in dried stains: "Practically it is not possible to distinguish between them."

Stevenson (in Taylor's *Manual of Medical Jurisprudence*, Philadelphia, 1892, eleventh American edition, p. 277) writes as follows: "It is generally admitted by scientific men that we have at present no certain method of distinguishing human blood from other mammalian blood when it has once dried on an article of clothing or a weapon. This is practically the form in which the problem usually comes before the medical jurist. He may be able to state that the shape and size of the corpuscles as seen by the microscope are consistent with the blood being mammalian and probably human, but it is impossible to say with absolute certainty that it is not the blood of an animal, like the ox or pig."

Expert testimony in which distinctions are attempted between human and other mammalian blood based on differences of 1–10,000 to 1–15,000 of an inch are not generally regarded with favor either by judge or jury.

Such niceties of distinction are looked upon with considerable skepticism by jurymen accustomed only to measurements in feet and inches.

If the witness is able to say that "stains are of mammalian blood and that the diameters of the corpuscles are consistent with human blood," and if he expressly states that they may be of other blood, he is giving testimony which will doubtless be accorded the weight to which it is entitled, and which cannot be effectively contradicted by the defense. On the other hand, extreme opinions given in evidence always lead to contradictions between opposing experts, the result of which is that the jury are confused instead of assisted, and generally disregard all the expert testimony upon that branch of the case.

In the trial of Leavitt Alley in Boston in 1873 evidence was given by a medical witness called by the government that certain blood-stains were not those of a horse, and that the difference in the size of the corpuscles of this animal and man in dried stains could be "distinguished as easily as pease and corn." The defense, as might be expected, brought other witnesses who disputed the radical opinions which had been given, making the case, for the time being, "a trial of blood-stains" and not of the defendant. The testimony as to blood, while of no direct benefit to the defendant, was a source of weakness to the government. More moderate opinions would, no doubt, have been received with favor and could not have been disputed. The slight importance attached to the opinions of the six expert witnesses who testified may be inferred from the charge of Judge Wells. His only allusion to the experts was as follows: "Perhaps the jury might not think it worth while to consider the difference between the medical experts, but if they could get any help out of it they would give it such weight as it deserved."

In the case of *Reg.* vs. *Nation* (quoted by Taylor) it was contended by the prosecution that a certain knife had been used for cutting the throat of a man who had been murdered. The defense claimed that the knife had been used for cutting raw beef. A government expert testified that the knife had been stained by *living blood,* and that it was not the blood of the ox. Chief-Justice Cockburn, in commenting upon the evidence of experts, said: "In admitting the advantages of science, they are coming to great niceties indeed when they speculate upon things almost beyond perception," and he added that he would *advise the jury not to convict upon this scientific speculation alone.*

Menstrual, Arterial, and Venous Blood.—The question may arise whether certain stains are of menstrual blood. There is no distinguishing chemical or microscopical test by which blood of this character and that flowing from a wound may be determined. Certain well-known chemical differences exist, but they do not furnish a basis for any reliable conclusions in dried stains. Menstrual blood under the microscope may show epithelial scales from the vagina. Vaginal epithelium resembles that from the mucous membrane of the respiratory organs and of the whole alimentary canal; hence, blood from a hemorrhage, from the bowels, or from piles might be mistaken for menstrual blood. For the medico-legal comparison of menstrual blood and that of other stains, see *Annales de Hygiene,* 1858, vol. x., p. 421. No distinction can be made between venous and arterial blood based on chemical or microscopical examination.

Age of Stains.—The color of blood-stains (crimson or dark brown)

and the spectroscopic examination may, under special circumstances, warrant the conclusion that the blood is comparatively recent or otherwise. Beyond this nothing can be determined with certainty.

Fig. 20. Epithelium from the Vagina. (After Ultzmann; 300 diameters.)

Undue Importance Attached to Small Stains.—An unwarranted importance is often attached to small stains upon the clothing of persons accused of crime. Taylor mentions the case of a man tried for murder upon whose shirt were found minute spots of blood, which were regarded as proofs of guilt, until it was explained that they were probably derived from flea-bites, and that some were on one side and some on the other, showing that the shirt had been worn on the two sides. The stains made by crushing the cimex and the mosquito show unchanged corpuscles of human blood. The clothing worn by the laboring classes may show blood-stains derived from various innocent sources which an accused person might be entirely unable to explain. On the other hand, nothing can be more erroneous than the very common idea that no person can commit a murder in which blood is effused without having his clothing more or less stained. Taylor gives many instances in which he had examined clothing worn by persons subsequently convicted of murder, and either no blood was found on any part of the dress, or only small spots wholly out of proportion to the amount of blood which must have flowed from the wounds of the deceased. (*Principles and Practice of Medical Jurisprudence.*)

ILLUSTRATIVE CASES.

CASE I. ATTEMPTED DISTINCTION BETWEEN THE BLOOD OF MAN AND THE COW.

(Abridged from Casper's "Handbook of Forensic Medicine," vol. i., case lvi.)

REPORT OF PROFESSORS CASPER AND DUBOIS-REYMOND.

A man was struck bleeding and senseless upon the highway and afterward robbed. A party was arrested for the crime whose boots exactly fitted some footprints in the snow at the place of the robbery, and upon whose trousers was a bloody stain the size of the palm of the

hand. This he explained by saying that during the Christmas just passed he had assisted at the slaughtering of a cow. This statement was found to be correct, and the trousers were sent to Professor Casper with the request that he would determine microscopically whether the blood-stain arose from human or cow's blood. The examination was made jointly by Professors Casper and DuBois-Reymond. Their report in part was as follows:

"Investigations of this nature are rendered more difficult by the blood not being perfectly recent, and also by the question lying between the bloods of such animals as have their blood-corpuscles of similar form. The latter is particularly the case in respect to the blood-corpuscles of man and those of most of the mammalia, particularly oxen, in so far as both are uniformly circular, and the human blood-corpuscles merely somewhat greater in diameter than those of oxen. At our first microscopic examination, on the 8th of February, we once more completely satisfied ourselves on these points, for *recent* human and ox blood having been compared together *the difference could most distinctly be made out;* also, after mixing both kinds of blood together, the smaller corpuscles of the ox could be readily distinguished from the larger human ones. We then proceeded to the *corpus delicti*. Portions cut from the blood-stain on the trousers were soaked in pure neat's-foot oil and examined, but instantly the utmost variety and uncertainty of opinion began to prevail among the observers present because the form of the blood-corpuscles was indistinctly seen. The blood-stain in question, moreover, at the time of examination might have been six and was at least three weeks old, and could therefore only present to view perfectly shriveled blood-corpuscles, which always give an uncertain result. In order to test the contrary opinion advanced by a recent author (Schmidt), . . . we experimented by dropping upon other parts of the same trousers recent human and recent ox blood, laying the pieces of cloth aside in precisely similar conditions for eight days to dry. On the 15th of February we proceeded to our second microscopic investigation by soaking both these stains in bone oil, and bringing them under the same microscope, first examining each stain separately, and afterward mixing the bloods together. The result was that although the dried human blood seemed to have more resemblance to that of the *corpus delicti* than the dried ox blood had, yet the form and diameter of both kinds of blood were so much altered by the shriveling they had undergone that it was perfectly impossible to give a decided opinion upon the subject. We must therefore give it as our opinion that *it is impossible to state with certainty whether the blood-stain on the trousers of the accused is caused by the blood of man or the cow.*"

CASE II. HUMAN BLOOD OR THE BLOOD OF THE DUCK.

(Abridged from "Annales de Hygiene," 1857, vol. viii., p. 369.)

REPORT OF PROFESSORS ROBIN AND SALMON.

The following is an extract from a report by Professors Robin and Salmon upon the examination of stains upon a cotton blouse belonging to one Doiteau, accused of murder. The blouse was taken from the

prisoner about eight hours after the commission of the crime with which he was charged, and appeared to be stained with blood. The defendant attempted to account for the stains by the story that he had killed a duck. One of the questions submitted to the experts was in substance the following: "Are the blood-stains those of a duck *or* from the body of a murdered woman of about seventy years of age?" The answer of the experts was as follows:

"The dark reddish-brown stains upon the blouse have been produced by blood. . . . We are warranted in this conclusion since blood is the only fluid containing the red globules which we have separated from these stains; in blood alone are found these bodies, together with fibrin and the white globules which we have recognized in the network which it forms. The microscope only can determine this question, for these stains are too small to allow of the detection of albumen: moreover, albumen having all the characteristics of the albumen of blood is found not only in a great number of animal fluids, but also in the colored or uncolored juices of plants, while blood alone contains at the same time the fibrin, the flattened circular red globules—destitute of a nucleus—and the white spherical globules, showing from one to three granules after the action of acetic acid. . . . But the elements of blood which compose these stains are not those from the blood of the duck; they have, on the contrary, all the constituent elements of human blood; they have neither the oval form, the dimensions, nor the central nucleus which are found in the red globules from either fresh or dried blood derived from ducks or other birds.

"The elements of the blood forming the stains upon the blouse are those of human blood, for they contain fibrin and respond to the reactions of acetic acid, etc.; the white globules are found in these stains, and they have the volume, the form, the granulations, the nuclei, and the chemical reactions belonging to the white globules of human blood. The red globules are found, also; they have the volume, the flattened circular biconcave form, the pale reddish-yellow color which are seen in the red globules of human blood viewed by transmitted light in the microscope, and, like these, dissolve in water and acetic acid without leaving any traces behind them.

"But in the present state of science, it is impossible to determine, by the examination of this blood, either the sex or the age of the individual from whom it flowed."

Case III. Possible Human and Sheep's Blood Present at the Same Time in Stains upon Clothing.

REPORT OF A JOINT EXAMINATION BY PROFESSORS WORMLEY, CHASE, HARRIMAN, AND BABCOCK MADE DURING THE PROGRESS OF A TRIAL BY ORDER OF THE COURT.

In the month of January, 1875, the dead body of the wife of a farmer named Emerson, residing in Piermont, N. H., was found about nine o'clock in the morning with the head entirely blown off. The body was still sitting in a chair near the stove in the kitchen of the house; the right hand held a needle with which the deceased had been sewing, and

scissors and thread were in her lap. A recently discharged gun, the butt-end farthest from the body, was found two feet behind it. There were but two persons about the premises at the time—the husband and a man of about sixty years of age, a visitor named Sawyer. The latter was arrested for the supposed murder. There had been no trouble of any kind between the members of the family, and no motive could be assigned for the commission of the deed. The gun, which belonged in the house, had been loaded by the husband with a heavy charge of shot on the night before the tragedy, for the purpose of shooting a strange cat which had been prowling about the premises. Blood in several small stains was, some days after the homicide, found upon the clothing both of Sawyer and of the husband, but the expert for the government declared that the blood upon the clothing of the prisoner was "probably human blood, as the corpuscles measured 1–3400 of an inch in average diameter," while that upon the husband's clothing was "probably sheep's blood, the corpuscles having an average diameter of 1–5840." Emerson stated that about a week before the affair he had killed a sheep, and this was proved by several witnesses. Circumstances developed which pointed strongly to the theory of accident: that the husband with mittens on his hands and icy boots had hurriedly gone into the house to get the gun for the possible chance of shooting a fox which was being pursued by dogs a short distance down the road; that with his snow-covered boots he probably slipped upon the wooden floor, and that the gun was accidentally discharged; and that the husband, fearing the consequences, denied all knowledge of the occurrence.

Under these circumstances the counsel for the prisoner demanded a reëxamination of the clothing of Emerson. The court granted the request, and appointed four experts, representing both the government and the defendant, to conduct a joint investigation to be made during the progress of the trial. Professors Wormley, Chase, Harriman, and Babcock were selected for this service. The writer acted as secretary of this board of experts, and in giving the results of the inquiry testified substantially as follows:

"Our examination, in which all agree, shows:

"1. In numerous places, both upon the jacket and overalls of Emerson, there are blood-stains.

"2. The stains are of mammalian blood.

"3. The very marked difference in the size of the corpuscles in the different stains indicates two kinds of blood. One kind is like that which belongs to such animals as man, the dog, monkey, rabbit, guinea-pig, etc., and the other kind is like that found in animals having much smaller corpuscles, as the sheep.

"The measurements of the corpuscles of the larger kind were from 1–3300 to 1–4200, and averaged about 1–3500. The corpuscles of the smaller kind averaged 1–6000 of an inch, and varied from 1–5000 to 1–7000."

(Figures showing the details of a large number of measurements were here given.)

"The micrometer used for the measurements was one which had been verified by Professor Wormley. The larger corpuscles were within the range of the average of human blood, and could not have been from the blood of the sheep, as they were much too large. The

smaller corpuscles were consistent with the presence of sheep's blood."

The jury disagreed as to their verdict, but the majority were in favor of the defendant. Under the circumstances, the government being satisfied that there was no more evidence against Sawyer than against Emerson, and it being doubtful, even, if there had been a murder, consented to the release of the prisoner, upon nominal bail.

SEMINAL STAINS.

The seminal fluid is a viscous and opaline fluid of peculiar odor and slight alkaline reaction. It contains about eighty-five per cent. of water and fifteen per cent. of solid constituents. But little is known in regard to the nature of these solids beyond the fact that they contain albuminous principles, extractive matters, a small amount of fat, and salts. The latter are principally calcium phosphate and sodium in combination as albuminates. There are no characteristic chemical tests by which this secretion may be identified in a dried stain.

Examined by the microscope under a power of three hundred or four hundred diameters, the fluid is seen to contain more or less numerous so-called animalcules, or *spermatozoa*. These structures consist of a flattened pear-shaped portion called the head, and a long filament or tail. The latter is thickest at the end nearest the head, and has a terminal portion of extreme fineness. The tail is ten or twelve times the length of the head, and on account of its extreme transparency may be invisible except in its thicker portion, thus appearing much shorter than its actual length. The addition of a drop of solution of eosin or of iodine in potassium iodide brings out the entire length of the tail with distinctness. The head at its broadest part is a little more than one third the diameter of the human blood-corpuscle. According to Lehmann, the head measures from 1–5300 to 1–4500 of an inch in length, and from 1–16,000 to 1–9000 of an inch in breadth; the tail has a length of from 1–600 to 1–450 of an inch, but may be, in some specimens, no more than 1–1000. The seminal fluid contains also epithelial scales, mucus-corpuscles, and spherical bodies called *seminal granules*.

Seminal stains on cotton or linen when held near the fire become pale yellow. According to Orfila, this effect of heat is characteristic, and is different from its action upon all other discharges. If moistened with water and warmed, there is developed the peculiar odor of the seminal fluid. These tests must be regarded only as indications, and in no case should a stain be pronounced as of seminal origin unless the microscope shows the presence of spermatozoa. It is true that under certain conditions these bodies may be absent from the secretion, but in such a case there can be no absolute proof that the suspected stain is of spermatic origin.

The following method, proposed by Koblanck in 1853, may be adopted for the preparation of specimens for microscopical examination: A portion of the stained linen about one-half inch square is moistened with a few drops of pure water contained in a watch-glass. The glass is covered to protect it from dust, and the linen allowed to absorb the water for an hour or more. The stain should be moistened only, not immersed in

the water, and the latter should be in no greater quantity than is sufficient for the purpose. When the stain has been softened it is scraped lightly with a scalpel, a portion transferred to a microscope-slide, a drop of eosin solution added, and covered with a thin glass.

Hamlin (*Proc. Amer. Soc. Micros.*, 1883, p. 83) has described a process for the investigation of seminal stains which the writer has found to be much more satisfactory in its results than the usual method. If the stain is upon a fabric of cotton, linen, silk, or wool, a small piece about one-eighth inch square is cut out and laid upon a slide previously moistened with water, and allowed to soak for a half-hour or more, renewing the water as it evaporates. The cloth is then carefully frayed out into threads by needles, and covered with a thin glass for examination. Specimens prepared in this manner show the spermatozoa clinging to the fibers or lying in masses in the meshes of the fabric. By the usual process of soaking and scraping the greater portion of the spermatozoa are destroyed, and in stains of known origin evidence of their presence is only obtainable after long and persistent search, and even then but few specimens are to be found. Hamlin's method shows them at once and without difficulty.

The appearance of the spermatozoa under the microscope is highly characteristic, and there can hardly be a mistake in regard to their presence.

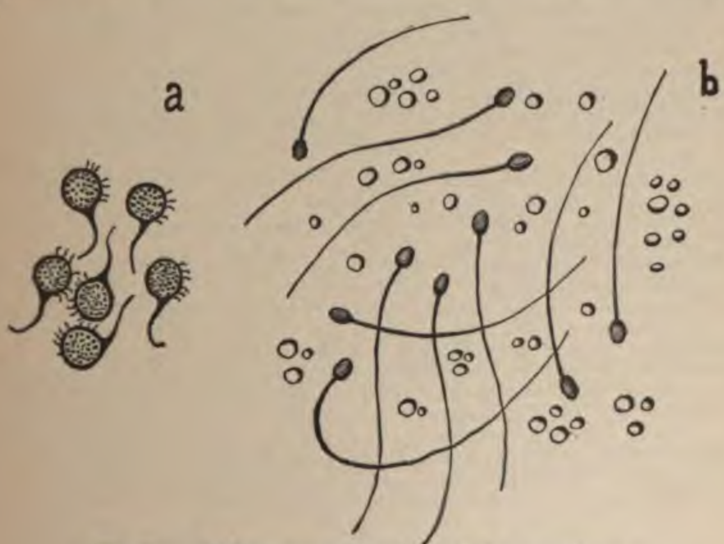


Fig. 21.—*a*, trichomonas vaginæ (Donné); *b*, spermatozoa.

No separated parts should be regarded. Spermatic granules may be mistaken for detached heads, and minute filaments from the stained fabric may appear like portions of the tail. Nothing less than the presence of complete spermatozoa should be deemed conclusive evidence that a stain is of seminal origin. In the examination of stains upon the linen of females careless of personal cleanliness and containing vaginal mucus, there may possibly be observed an animalcule described by Donné (*Recherches Microscopiques*, Paris, 1837) as *trichomonas vaginæ*. This organ-

ism has four or six short cilia attached to the head; the head is granular, and three or four times larger than that of the spermatozoon. The latter has no cilia, and both in its head and tail is transparent and structureless. Spermatozoa present in dried stains resist decomposition by atmospheric influences, and, if not subjected to abrasion by rough handling, may be detected even after the lapse of several years.

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HAIRS AND FIBERS.

BY

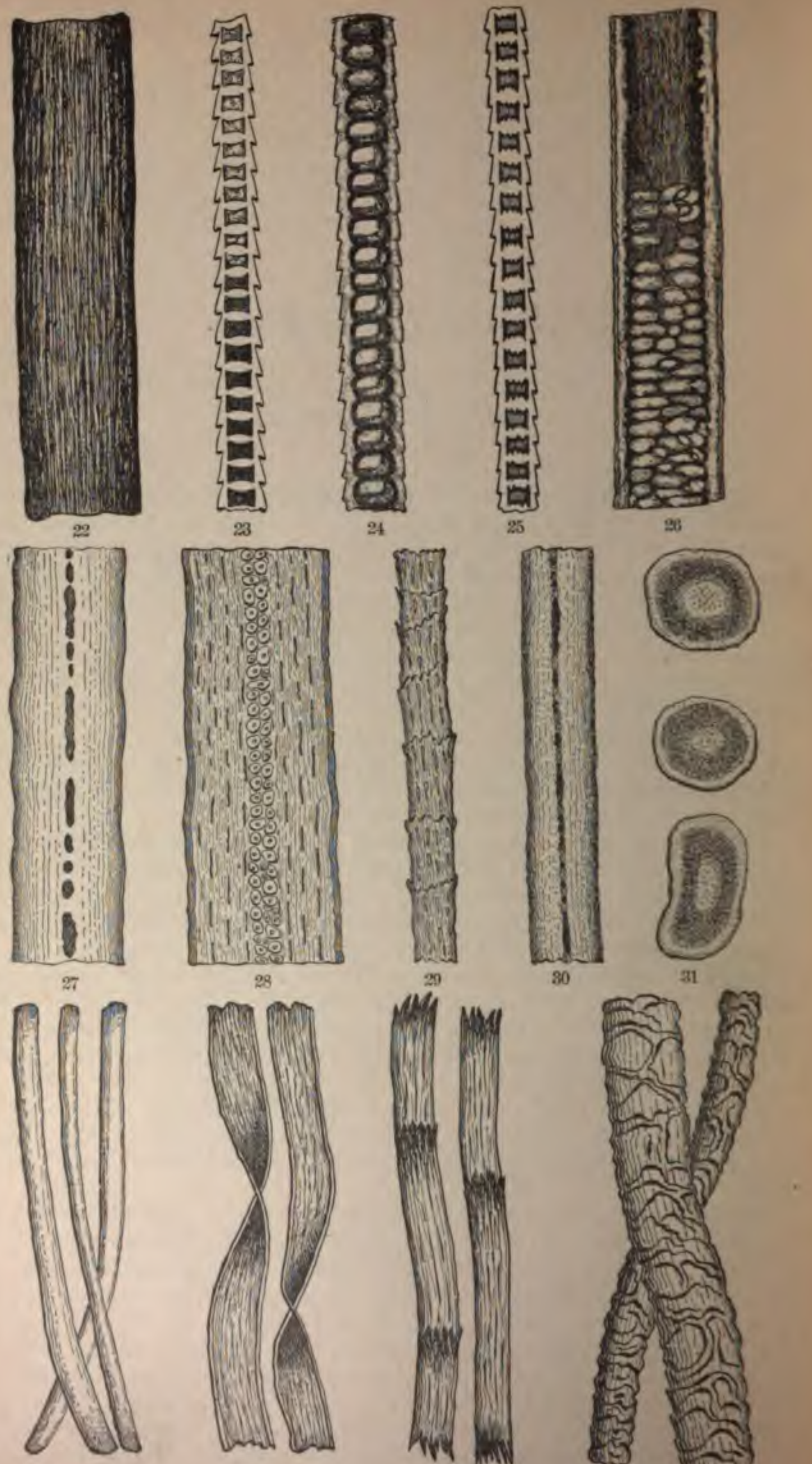
JAMES F. BABCOCK.

THE presence upon weapons or the clothing of a defendant of hairs from animals or of various fibers used in the manufacture of textile fabrics has in numerous cases proved to be of great importance in trials for homicide. In the trial of Rubenstein for the murder of Sarah Alexander a fragment of corn-husk and a fiber of wool from the shawl worn by the girl, found attached to a blood-spot upon the boot of the defendant, proved to be very important evidence. Taylor gives the case of a woman accused of murdering her child, upon whose clothing were found spots of blood with hairs from a victorine worn by the victim. In the Piper case, in which the sexton of a church was tried and convicted of the murder of a child in the belfry, a single hair found upon the person of the defendant was claimed by the government to be identical with that cut from the head of the deceased.

Hairs found upon weapons or clothing may be from the head or other parts of the human body, or from some domestic animal. As in the case above cited, they may be from the fur of a very large number of animals, of which many varieties are used in different forms as articles of apparel. Fibers may be of silk, wool, cotton, linen, or a mixture of these in the various kinds of textile fabrics employed for clothing. The identification of hairs and fibers is, in most cases, conclusive and satisfactory—i.e., it can be asserted with certainty that a given hair is human or from some animal, and in most cases the animal, or at least, the class to which it belongs, can be determined.

The diameters, length, and peculiar markings of hairs when observed in the microscope furnish the means for distinguishing them. Indeed, these are practically the only data by which reliable conclusions can be drawn.

Hairs from the human body may be classed in three different varieties: 1. Long, soft hairs from the head, from one to three or more inches in length; 2. Short, thicker, and more rigid hairs from one fourth to one half inch in length, as in the eyelashes; 3. Short and very fine hairs from one twelfth to one sixth of an inch in length, as the down or woolly hairs from the face, back, or extremities. In the microscopic examination of hairs two structures are visible: a median, more or less dark, and somewhat irregularly granular portion, the *medulla or pith;* and an outer fibrous-looking portion, colored according to the color of the hair, *the cortex or cortical portion.* Under certain conditions of focussing, hairs from the head show a very light portion in the center, giving the appear-



Microscopical Appearance of Hairs from Various Sources, and Vegetable and other Fibers.

Figs. 22 to 35.—22, horse (back); 23, mouse; 24, cat; 25, chinchilla; 26, large hair from seal; 27, hair from head of female, age, eighteen; 28, hair from head of man after treatment with caustic soda; 29, fine hair from back of hand; 30, from head of child; 31, cross-sections of hairs from the head; 32, silk; 33, cotton; 34, flax; 35, wool. [J. F. Babcock—Del.]

ance of a tube; but this is merely the effect of refraction, and disappears when the hair is examined after a preliminary soaking in a weak solution of caustic soda.

The diameters and lengths of hairs vary greatly, according to their position or the age or sex of the individual. Hairs from the head are usually longer, softer, and finer in females than they are in males. Hairs from children are softer and finer than those from adults. The long hairs from the head average about 1–350 of an inch in diameter in man and 1–450 in woman. The downy hairs from the body (lanugo) vary from 1–1000 to 1–3000 of an inch in diameter. Hairs from the eyebrows, the pubes, and the mustache are about 1–200 of an inch; on the back of the hand in man they vary from 1–250 to 1–500 of an inch. These figures are subject to considerable variations in different individuals, but may be taken as showing the comparative diameters of the hairs from different positions. Variations to a somewhat similar extent occur among animals. Most mammals have two or more varieties of hairs, one long, stout, and straight, and overlying others which are much finer and shorter. The peculiar markings and other appearances of these hairs may vary greatly even in the same animal, according to its situation, or whether they are of one or another of the varieties above mentioned. Figures showing the appearance of various animal hairs under the microscope may be found in the *Micrographic Dictionary* of Griffith and Henfrey (plate 29), and other drawings in the *Proceedings of the American Society of Microscopists*, 1884, p. 59, and in Woodman and Tidy's *Forensic Medicine*, p. 498.

Hairs for microscopic examination should be soaked in oil of turpentine and mounted in Canada balsam. The accompanying plate, together with the drawings to which we have referred, may be useful in determining the character of any particular specimen; but in all cases the latter should be compared with hairs of known origin before arriving at a definite opinion.

Silk fibers are cylindrical in form, and exhibit a strong refraction of the light passing through them; they are almost entirely devoid of markings of any kind or other peculiar structural appearances. *Wool* has irregular fibers, and the transverse markings are very large and noticeable. *Cotton* has a spiral and twisted structure. *Flax* has fibers which are tapering toward the point, and they show joints at unequal distances. A solution of eosin or of any of the aniline colors produces a strong dye upon silk or wool, but upon cotton only a feeble and easily washed out stain.

No reliance can be placed upon conclusions drawn from the appearances presented by a single hair as to the identity of the individual to whom it belonged. This has been attempted in many criminal trials, with results almost invariably damaging to the side which has attempted it. All that can be fairly stated in such cases is that hairs from some particular head have a resemblance.

The reader may consult with profit a paper by William J. Lewis, entitled "Hair Microscopically Examined and Medico-Legally Considered," in *Proceedings of the American Society of Microscopists*, 1884, p. 59. Also articles by Lassaigne, Robin, and Orfila in *Annales de Hygiene*, 1857, 2d series, vol. viii., p. 226; 1858, 2d series, vol. x., p. 434; 1835, 1st series, vol. xiii., p. 466.

IDENTITY OF THE LIVING.

BY

ALLAN McLANE HAMILTON, M.D.

TRIALS where instances of mistaken identity have been the issue are so numerous and curious as to form many of the causes *célèbres* of all times, and have reflected perhaps more upon the value of human testimony than any other influence. Plentiful cases upon record prove either how poor is the observation of the ordinary individual, or how common are certain appearances which have been looked upon as more or less striking peculiarities. Many interesting questions have arisen in connection with identification, not a few of which have formed the basis of legal proceedings, and the literature of medicine is full of dramatic instances of mistaken personality. While under some circumstances persons who have had ample opportunity for observation make the gravest errors in identification, on the other hand it is sometimes the case that a momentary glance in the shortest possible association has sufficed for a perfect identification.* It often happens with our own authorities that persons who have been robbed will readily pick out the guilty person from a score of others in whose company he may be placed; but possibly this facility is owing to the manner and anxiety of the culprit to escape detection as much as anything else.

The matter of systematic identification is largely a question of practice and skill, but in some measure depends upon the faculty of intuition, which, however, does not belong to many. It is certain that the power of unconscious observation is possessed by some individuals to a marked degree; and while these persons never forget a face, they are quite unable to explain their quickness or the means which enables them to reach a conclusion. An expert detective sergeant with twenty years' experience, who is known as having one of the best memories and the sharpest wits of the New York police force, tells me that he rarely looks at other

* Considerable space is devoted in some works of this kind to the momentary recognition that often takes place where the only illumination is the flash of a pistol or the gleam of lightning. In many instances these examples are grossly exaggerated. Cauvet conducted a series of experiments, the conclusions of which are the following: (1) That the person firing a pistol may be recognized if the observer is placed very near him—say five paces—and at the side of the line of fire; (2) that he may be recognized when the discharge has been in a close place of small dimensions, and the observer is in a stooping posture or squatting; (3) that the chance of distinguishing the person firing is affected by the quality of the powder employed, the best English powder enabling the observer, when near or by the side of the person firing, both to see and identify him.

features than the eyes, and usually by their expression and color he remembers his man. It is a well-known fact, however, that those whose occupations should make them familiar with particular persons are singularly untrained in the matter of identification, such being the case with portrait-painters, a great many of whom are unable to retain an impression of a sitter five minutes after his departure, or to be able to paint the portrait in his absence.

UNRELIABILITY OF EVIDENCE.

The most astonishing examples of confident identification are found in books and the daily press, which often relate instances of individuals who were perfectly sure of the identity of another, but whose positive declarations were afterward proved to be valueless by the appearance of the real person. Such a condition of affairs occurred in the Tichborne case (see Identity and Survivorship), where Arthur Orton was recognized and whose cause was championed not only by the mother of the real heir, but by the old friends and servants of Sir Roger Tichborne.

It seems almost incredible, but women have lived upon the closest intimacy with men who have turned up long after the disappearance of their lawful spouses, firmly believing them to be their long-lost husbands.

"In one of the early criminal records of New York City we find the history of one Joseph Parker who was tried for bigamy in the year 1804 in the court of Oyer and Terminer, the indictment charging that on the 8th of May, though he was lawfully married to one Susan Fearon, who was still living, he had unlawfully, on the 25th of December, under the name of Thomas Hoag, contracted a second marriage with one Catherine Secor. The first marriage and the present existence of the first wife being admitted, three witnesses then testified that the defendant then in court before them was the Thomas Hoag who had come to Rockland County, thirty miles distant from New York City, in September, 1800, had lived there working as a laborer, had married Catherine Secor on Christmas Day, 1800, and in the following March had disappeared. One of these witnesses was the woman who claimed to be his wife; another, the judge who married them; and another was a man who had worked with him constantly for five months. They were positive the defendant was Thomas Hoag, and recognized him not only by his features, but by various marks and scars on his person, and by a certain impediment in his speech. On the strength of this testimony, which must have seemed conclusive, the prosecution rested, and the defense called six witnesses who swore just as positively as the others that the defendant was Joseph Parker, that he was by occupation a rigger, and that he also served on the city watch. And they swore with equal positiveness that on Christmas Day, 1800, and before and after that date, he was in New York City following his usual occupation, and by no possibility could he have been at that time in Rockland County. With this testimony the defense rested, but the prosecution seems to have had other evidence in reserve. Seven additional witnesses were now called for the prosecution, each of whom in the most positive manner identified the defendant as Thomas Hoag, who had married Catherine Secor on Christmas Day, 1800. They swore to various marks on his face and neck, which the defendant plainly

had, but particularly a deep scar on the ball of his foot, occasioned by treading on a drawing-knife.

"The prosecution closing their case, the defense called two more witnesses, one of whom was the mother of his wife, who had known him for sixteen years, and swore positively that he had not been out of New York more than a week during that time; and the other swore to working with him on the particular Christmas Day in question. It was then agreed by the counsel that the defendant should show the soles of his feet to the jury, that they might ascertain whether the peculiar scar upon one of them, which had been sworn to by several of the witnesses for the prosecution, was visible. Upon exhibiting his feet no mark or scar could be seen upon either of them.

"The captain of the watch was then called, and after swearing positively that the defendant was Joseph Parker, whom he had known for many years, he produced his books, in which he kept a register of the watchmen and their times of service, and showed that from October, 1800, till March, 1801, defendant was on duty as a watchman in the city. The jury, without retiring, found a verdict of not guilty."

When it is borne in mind that the witnesses on both sides of this most astonishing case were persons of responsibility, and of such standing as to preclude all thought of perjury, it must be admitted that it presents one of the strangest examples of disputed identity ever known.

The similarity of two individuals some time ago induced a lawyer in the city of New York to resort to a ruse for the purpose of clearing his client, who had been accused of a serious crime. While the latter was seated out of range of vision of the witness in the box, who was very decided in his opinion of his own powers of observation and his certainty of the appearance of the assailant, the double of the man under trial was told to arise, when he was positively identified by the confident witness. His mistake, of course, led to the discharge of the prisoner.

ACCIDENTAL OR VOLUNTARY ALTERATIONS IN APPEARANCE.

In investigating the history and condition of the person whose identity is suspected, it is of the utmost importance that the examiner should give weight to two kinds of influences that may effect an alteration, viz.:

1. Those in which the changes are due to age, disease, and natural or accidental alteration;

2. Those in which the alterations are willfully produced.

To the former belong the organic and facial expression changes due to insanity, to trophic changes in which pigment bleaching or deposit takes place, to the loss of teeth or hair, or through cutaneous disease with pitting or other lesions. To this class belong the existence of accidentally produced cicatrices, the loss of limbs, deformities, etc., and the appearances due to manual or other labor.

In the second class we find changes voluntarily wrought which are sometimes willfully brought about for a purpose, or occasionally exist as evidences of former vanity. In this group we are presented with cases where we are required to determine whether the hair has been dyed, whether abrasions, wounds, or burns have been made for a purpose, and whether tattoo or other marks have been removed, or, on the other hand, executed

with the intention of counterfeiting the marks upon the body of some person who has disappeared or died, for the purpose of perpetrating a fraud.

The determination of the indications of age is sometimes an issue, especially where a claimant presents himself; and we may divide the important periods of life into *adolescence*, which begins at the age of puberty and lasts until twenty-five, *adult life*, which is prolonged until the sixtieth year, and *old age*, which may be said to begin at sixty and last until eighty-five, when *decrepitude* commences.

It is only exceptionally that we are called upon to determine the age of children, but such may be necessary in cases of rape, the question of consent, or possibly where the applicability of the laws of the Society for the Prevention of Cruelty to Children is questioned; but there is usually little difficulty in closely approximating the period of infantile life.

The exact determination of the age of the adult is extremely difficult where it is necessary to be precise, and the same may be said to be the case with old age. Of course, in the latter the association of evidences of bodily decay must be more or less consistent and harmonious, for in men in their prime, so far as time is concerned, we often find indications of premature decay. We must take into account the nature and form of the inferior maxilla, the condition of the teeth, rigidity of articulation, possible existence of friable bones, coldness of the extremities, weakness of the genital apparatus, troubles of excretion and circulation, as well as that mental weakness which is manifested by loss of memory, and ultimately by childishness. In addition to these, the presence of the *arcus senilis*, weakness of vision, and alteration in gait and carriage may be recognized.

Change through the Effect of Disease.—As every one is aware, a notable facial change takes place as the result of many general diseases, so that sometimes what amounts to an almost complete loss of identity

Fig. 36.

Fig. 37.

occurs. Those especially who are in the habit of examining the insane cannot fail to be impressed with what I mean. As an illustration, two

pictures may be presented of a young married woman who was indicted for infanticide in a town in the northern part of New York (Figs. 36 and 37). But one year elapsed from the time the first picture was taken until commission of the crime, and it was during her incarceration in prison before the trial that the second photograph was made. Her insanity had not been recognized by her townspeople, and in fact, it was of a low order. So rapid a change in appearance can hardly be conceived, and I am sure under certain circumstances would lead to a mistake in identity. Certain atrophic affections of the nervous system, which are attended by loss of hair, discoloration of the skin, and various other metamorphoses, can produce a startling transformation.

The Teeth.—The coloration of the teeth may have something to do with the determination of personal identity, and Tardieu has referred to the existence of erosion, separation, and other changes due to the habitual use of the pipe in smokers. It is the custom with most dentists to keep accurate records of the nature of the work done by them, and, when possible, such data should be consulted to ascertain the history of the person whose place has been usurped by the impostor.

Changes in the Hair.—It is often a difficult matter to determine the identity by the color and condition of the hair. Criminals and others, for the purpose of disguise, have by means of dyes wrought a change in appearance which has been more or less effectual. Perhaps, after all, a knowledge of the configuration of the head and the natural growth of hair among people of different temperaments may guide the examiner as much as anything else; and, of course, the relation of head coloration to that of other regions will enable him to expose a fraud, for it is rare that any systematic and harmonious dyeing is resorted to. It is often necessary to bring the microscope to our aid, when it will be found that the imbibition of the dye does not extend throughout the hair-trunk, but there is a spot which presents normal and uniform color. This aid will also disclose the adherence of fatty particles which have followed the use of various pigments. Vibert has pointed out the fact that hair dyed with black presents under the microscope a coloration apparently everywhere uniform, which is never the case with that which has preserved its natural color. If the dyeing is imperfect there will be brusque changes in color and none of the gradations that belong to a normal condition. Blond tints, which are nearly always obtained by the use of peroxide of hydrogen, result in a discoloration of the pigment without destruction. In nearly every case where several days have elapsed between the last application of the dye and the time of examination there will be ordinarily no difficulty in detecting the change in growth.

Briand and Chaudé have written extensively upon this subject, and have given certain instructions for the examination of the hair of suspected persons. When lampblack combined with some fatty substance has been applied, it will be necessary to wash the hair in ether, which will rapidly remove the fatty substance, leaving the carbon in suspension in the liquid. Sometimes a mixture of litharge, chalk, and lime water is used, and the effect is produced after two or three hours. When the head is well washed with warm water and a small quantity of acid is added, the presence of these substances may be determined by the effervescence, and the subsequent addition of sulpho-hydric acid and oxide of ammonia indicates the existence of lead. Slow dyeing produces a much

more obstinate and less easily removable tint, and in such cases it is well to get some of the hair and treat it thoroughly with the above reagents. The salts of bismuth and sulphur are often used when it is desired to obtain a more rapid coloration, and ordinarily with the latter agent the hair is washed in ammoniated water, and afterward, while damp, saturated with metallic salt, and then put in contact with water containing hydrosulphuric acid or sulphur. Decoloration after dyeing with nitrate of silver can usually be effected with cyanide of potash and pyrogallic acid, and sometimes a weak solution of hydrochloric acid will change the color of hair thus dyed from black to a more or less violet hue. Briand and Chaudé believe that the best means for recognizing the nature of a salt which has been used to color the hair is to burn a part of the hair and to treat the ashes by nitric acid evaporated to extreme concentration, and then afterward to apply the ordinary tests for silver or lead.

Orfila (*Traité de Méd. Leg.*, T. i., p. 122 et. seq.) has stated that locks of black hair when plunged into chlorine water pass from a light chestnut color to deep blond, clear blond, and finally become entirely bleached. After a long immersion in chlorine water the hair preserves for a long time the odor of chlorine, and becomes brittle. Red and brown tints are obtained by means of saffron and the permanganate of potash.

We should not lose sight of the fact that at times it is necessary to determine the individual type so far as hair, features, etc., are concerned, and while, of course, such identification is not in itself a matter of certainty, anthropological aid may be unexpectedly suggestive. The abundance of hair in relation to race type is, according to many observers, very variable. The plate from Testut (*Traité d'Anatomie Humaine*, T. iii, Fas. 1, Paris, 1892) (Fig. 38), taken in consideration with the researches of Hilgendorf, Withof, and others, may prove of service in determining the race characteristics in appropriate cases. The former counted in a square centimeter 272 hairs in a German, 252–286 in a Japanese, 214 being the average among the Ainos (the hairy tribe of northern Japan). Withof has found that the hairs are more numerous in blond subjects than among those of darker skin and coloring. He has counted 147 black hairs, 162 brown, and 182 blond in a quarter-inch.

The classification of hair, as agreed upon by Isidore Geoffrey, Saint-Hilaire, Huxley, and Haeckel, is as follows:

- Primitive man.
  - Woolly hair.
    - In tufts.
      - Hottentots.
      - Papuans.
    - Fleecy.
      - African Blacks.
      - Kaffirs.
  - Straight hair.
    - Stiff.
      - Australians.
      - Hypoboreans.
      - Americans.
      - Malays.
      - Mongolians.
    - Curly.
      - Dravidians.
      - Nubians.
      - Mediterraneans.

The finger-nails may be the seat of changes due to the particular work of the person, or to previous disease. Esbach (*Modifications de la*

Phalangette dans la sueur, etc., Paris, 1876) has carefully examined a great many finger-nails, and announces it as a fact that it is possible by the breadth, thickness, and shape of the nail not only to distinguish tuber-

Fig. 38.—1 (Straight), American Indian; 2 (wavy), French child; 3 (frizzly), Australian; 4 (fleecy), Tasmanian; 5 (bushy), New Caledonian; 6 (kinky), Zambesi. (Testut.)

culosis, but he finds that typhoid fever, chloro-anæmia, and gestation effect and leave a marked variation in the thickness of the nail. He gives several tables which show the influence of the different callings upon the thickness of the nail, and finds that those occupations in which the hands are used to a very great extent, and where there is habitual sweating, the nail substance is increased.

GENERAL STIGMATA OF OCCUPATION.

It is possible sometimes to fix with certainty the occupation followed by the suspected person by various marks, such as softening or destruction of skin, deep fissures, destruction of nails, and the formation of cysts, tumors, or callosities; changes in the trunk; coloration of the

skin, or corrosive action exerted upon the same by substances used in manufacture. It is requisite to bring to our aid the help of chemistry, and to carefully examine the traces of organic or inorganic discoloration, the parings of the nails, or the dirt that may accumulate beneath them, the stains upon clothing, and to carefully note the deformity of the fingers or body, the expansion of the finger-tips, the retraction of the flexor tendons, to recognize the duration or age of such appearances; and we should naturally examine the hands first.

The Hands.—Le Grand du Saulle (*Traité de Médecine Legale*, second edition, p. 1015 et seq.) says that in four fifths of the workmen he examined the hands showed the only trace of the kind of work done.

Tardieu has by the condition of the hands recognized the following: laundresses, bleachers, copper-workers, coal-miners, coachmen, hair-dressers, tanners, cutters, hair-workers, nail-makers, porters, gilders, cabinet-makers, clerks, florists, engravers upon metals, watchmakers, locksmiths, milliners, mother-of-pearl workers, shoemakers, glass-polishers, button-makers, rag-pickers, tortoise-shell polishers, bookbinders, grinders, saddle-makers, stone-masons, drummers, dyers, wood-turners, metal-spinners, vermicelli-makers, and glass-blowers. He divides the alterations of the hand into those occupying the palmar portion, the fingers separately or together, the two hands or one only. The right hand is that in which the appearance is most often marked, and when both are changed, that of the right is different from the left; and it is nearly always found that the fold of the flexion in the palm has the greatest degree of epidermis thickening. When the entire hand is the seat of alteration, according to Du Saulle, we find that this is the result of the contact with some substance which produces a general alteration, as is the case with washerwomen, tanners, dyers, locksmiths, and saddle-makers. Changes in the feet are much more rare than elsewhere, but such changes are found among porters, tailors, and turners.

Shoemakers, lace-makers, clock-makers, and shell-polishers all present a change in the form, length, thickness, and wear of the nails, which signs are very characteristic.

RECOGNITION OF CHANGES INCIDENT TO SPECIAL OCCUPATIONS.

These professional stigmata are by no means absolute evidences of the occupation followed by the suspected individual, for there is a decided difference not only in the shape of tools used, but in the method of work of different mechanics; deductions, however, may be drawn which are more or less helpful, and, with other confirmatory data, will be of great service to the person making the inquiry.

Jewelers are apt to present a retraction of the last phalanx of the left thumb, and it has been held that cataract is more frequent as a result of the fine work which so many of them are in the habit of doing; nevertheless Desmarres, pére, out of nine hundred and fifty-two patients affected with cataract found but two jewelers. Sometimes cramp is found of the flexors which is analogous to that of writers and others.

Washerwomen do not always work in the same position, but when following a habit they present different deformities of the upper extremities, callosities due to the exercise of pressure, and sometimes a con-

dition of the skin of the hand with swollen fingers, which is highly characteristic.

Metal-workers and *burnishers* present sometimes in the right hand a general callosity and blackness, the creases of flexion remaining unaffected and unstained. The last phalanx of the little finger is often held in extreme flexion, the skin of the left hand which covers the back and the radial side of the index finger and is found over the head of the second metacarpal bone is very hard and callous, showing the same appearance at the extremity of the palmar face of the thumb.

Coachmen and *drivers* nearly always present a distinct spot of callous between the thumb and the index finger, and between the second and third and third and fourth fingers of the two hands. The first site, however, is most common.

Shoemakers. On their left hands where the thumb and index finger hold the thread the soft parts are broadened, and the fold which separates the second from the third phalanx of the index finger is cut by the thread, presenting a deep crevasse, the borders of which are hard and callous. On the thumb of the right hand the fleshy substance is expanded in spatulous form, which is quite broad and characteristic, and is like the analogous deformation met with among glass-workers.

A still more characteristic sign, and one which is more striking, consists in the depression of the nail of the left thumb, which is considerably thickened, hard, and at its free border is dentated, brittle, crenated, and sometimes deeply indented by sharp cuts from the awl. This aspect of the left thumb among working shoemakers is consistent, and really characteristic. There is a certain depression of chest, so that the sternum presents a distinct concavity which is very sharply circumscribed, and not accompanied by any general deformity of the thorax as a whole. The hair-bulbs of the skin of the thighs are obliterated, the skin is often rough, and in other ways shows evidences of pressure made by the lap-board.

Curriers and *tanners* present in both hands a great breadth of fingers, particularly at their base, and very hard and prominent folds, which correspond exactly with the line of flexion of the metacarpo-phalangeal articulations.

The hands of *curriers* sometimes present a deep brown discoloration, the result of a species of tanning which is distinct; if the spots are touched with a solution of prussiate of potash and iron, they instantly turn a darker color, and eventually become black.

Dressmakers and *seamstresses* present a familiar appearance which is unmistakable, consisting of a hardening of the index finger of the left hand, which is pierced by numerous needle-points; the skin is rough, thick, and blackened. It is true that these traces appear in many professions.

Workers in copper. The calloused skin of these workmen may be easily removed with the aid of a bistoury. The sections of epidermis of these people are thickened, and the nails of copper-workers are considerably thickened at the edges. If the detached skin and clippings of nails be put into boiling nitric acid and the solution subsequently treated by ammonia, it takes a beautiful blue color. The result is not always convincing. It is then best to burn the débris of the skin in a platinum crucible and treat the residue with nitric acid and ammonia. This result

was obtained even in a workman who for forty days had not worked, having been confined in a hospital. There are exceptions, however, but the process is generally a reliable one.

Boatmen and *seafaring* men, and others whose occupation causes them to come in contact with water a great part of the time, present a certain softening of the skin which varies in extent. In this connection Parent du Chatelet (*Annales d'Hygiene et Méd. Legale*, T. iii., p. 245) has described an affection which is designated under the name of "grenouille," and consists of an extreme softening of the skin, with actual disintegration of parts which are in constant contact with water. He has found both the superior and inferior extremities, but more often the latter, to be the seat of softening, so that there are vast tracks and crevasses of the depth of several lines between the great toes and the others. It is not rare to observe the same fissures in the palms of the hands, sometimes associated with redness and extreme sensibility.

Gilders. Signs which indicate the effects of work are detected in young workmen at the end of five or six months, at the anterior and internal part of the left forearm, where a considerable callous commences at the lower edge of the flexure which marks the separation of the forearm and the hypothenar eminence, with an elevation on the anterior part of the forearm to the height of five centimeters, and of considerable breadth. There are other marks which have been very positively connected with this trade by Du Saulle, and consist of various callosities which are produced by burnishing-tools.

Clerks and those who write extensively present a dermal hardening at the cubital edge of the little finger of the right hand, corresponding to the last phalangeal articulation, which is in the form of a corn, and is produced by the constant rubbing and pressure of the finger upon the paper. Sometimes there exists, besides, a hardened fold at the extremity of the middle finger at its radial side at the point where it comes in contact with the pen.

Workers in artificial flowers present a characteristic stigmata between the thumb and index finger of the left hand.

The formation of bursæ in various situations may throw some light upon the occupation or mode of life of the person whose identity it is desirable to establish. Housemaids and others who kneel a great deal present local prominences which, in the case of the former, have been recognized as a distinct surgical condition. These same appearances are not uncommon among nuns, priests, and religious devotees of all kinds.

SKIN LESIONS AND THEIR RESULTS.

Evidences of Cutaneous or Venereal Disease.—The skin presents appearances which, when taken alone, do not always afford a certain means of identification, but are occasionally extremely suggestive and important. No weight, except that which belongs to a fact that may be used in confirmation, can be attached to the existence of pitting or skin lesions which are permanent. It can be well understood how the mark of a venereal sore will influence the features of a case. Many of the lesions of tertiary syphilis last for a long time, if they are not permanent, and especially is

this the case where bony changes have occurred. The induration of the primary sore is not always of long standing, and the excavation or cicatrix left by a "soft chancre" may become obliterated in a comparatively short space of time. Ogston refers to a cicatrix left by a chancroid which disappeared in an unusually short period. In the case of rape referred to by this writer, evidence was brought forward by the defense to show that, in the female, soft chancres could not have existed after the period of intercourse, as no mark of their previous presence was visible about the genitals of the prisoner six weeks afterward. His testimony at the prosecution was that he and another physician had seen them at the time alleged. He was later the more confirmed in this opinion, from the fact that in a subsequent case in private practice, where several such chancres were met with and treated by him, all trace of them was found to have disappeared six weeks subsequently.

Cicatrices.—The duration of scars has been questioned upon many occasions, and the theory naturally suggests itself whether a scar ever entirely disappears. Ogston is of the opinion that as a rule "all scars resulting from wounds and cutaneous diseases which involve any loss of substance are indelible, the only exception that can be made being in regard to trifling punctured wounds where but little violence has been done to the skin and where there has been no loss of substance."

Before going further, it is well to say that the determination of identification by means of a scar is very often quite unreliable, unless the cicatrix be of a pronounced and prominent character. In a large number of collected cases I have been impressed with the positiveness of testimony as to certain body-marks, and in many instances it has been found that innocent persons have presented the scars that have served to fix the identification in the minds of obstinate witnesses. The following is a case in point:

John M. Poyn, a Cincinnati detective, had sworn out a warrant for the arrest of W. A. Hedden, of Tacoma, charging him with having defrauded life insurance companies out of over $14,000. He was arrested and bailed, and his examination was deferred two weeks, in order that additional evidence might be secured in Buffalo, where the alleged frauds had been committed. As he could not give bonds he was kept in jail for over a month, when he was released. He had been taken for B. A. Crandall, who in 1886 lived in Buffalo and had an insurance on his life for $14,000. He went West, and in that year it was reported that he had committed suicide. The evidence of such suicide was so strong that the companies paid the dead man's relatives in full. In 1887 Crandall had been seen at Los Angeles, and the fact reported to the insurance companies. They immediately offered a combined reward of $2000 for the arrest of Crandall, and detectives were placed on his track. Detective Poyn heard that Crandall was at Tacoma, went there and saw Hedden, whose resemblance to Crandall was great. He got acquainted with him, they went into partnership, and established a land-locating agency. Hedden's height, color of his eyes, beard, his size and weight exactly coincided with Crandall's. On the latter's right foot was a scar over four inches in length, the result of a wound accidentally inflicted upon himself with an ax when a young man. In order to find out whether Hedden had this scar, Poyn proposed that they should rent a room together, to which Hedden agreed. The first night when the latter un-

dressed the detective watched his room-mate, and discovered the scar; the following day a warrant was secured by Poyn, and Hedden was arrested; and now more positive evidence was needed from Buffalo, and the telegraph wires were kept busy. Hedden's photograph was taken and sent to Buffalo, and word came back that it was the picture of Crandall. Hedden asserted his innocence vehemently and repeatedly, and said that he owned a farm at Lake View, near Rochester, upon which his family were living; and two or three Tacoma people of prominence became interested and did all they could to help him. It subsequently transpired that persons who knew Crandall saw the prisoner, and while admitting that the resemblance was striking, said that the prisoner was not Crandall. After a long and bitter fight Hedden finally got his liberty.

It is a fact that must be patent to all that careful examination of a large number of scalps will reveal the presence of traces of long-forgotten injuries which have escaped ordinary observation, and these may be discovered for the first time by persons anxious to find something.

The Age of Cicatrices.—French writers have tried to fix with more or less certainty the date of formation of a cicatrix, but there is no absolute way of determining the exact time of the wound itself. Much, however, depends upon its situation, and character of the instrument used, and, after all, we can only be governed by the general rule of Casper, that "a white cicatrix indicates that the wound is not recent." Occasionally it is possible to determine the existence of the marks of a former solution of continuity by vigorous rubbing, which brings the blood to the surface.

A cicatrix is not always the consequence of a wound, for those left by a very sharp instrument may heal quickly without any trace, especially if antiseptic precautions have been taken; on the other hand, if no cicatrix remains to mark the alleged locality of a burn or stab of any magnitude, it is most probable that none has been made.

Tattooing.—Very often the identity of a suspected person may be determined by initials or inscriptions which have reference to some other person, or to his calling or previous life.

According to Lombroso, the greater number of tattooed criminals are among the recedivists and instinctive criminals, "especially those who have committed crimes against the person." Ellis (*The Criminal*, London, 1892, p. 104) says that "the fewest are found among swindlers and forgers, the most intelligent class of criminals."

In making an examination it will be found that among women of easy virtue, pædrasts, and tribades the designs are nearly always obscene, but it cannot be denied that tattooing among women is as a rule very rare. Alborghetti found that 40 of 100 children at the reformatory at Turin were tattooed, which was not the case with the children among the ordinary population. Greaves (referred to by Ellis) examined 555 tattooed persons in Derby Prison; 41 were tattooed, the subjects being chiefly soldiers, sailors, and miners.

The Question of Indelibility.—Considerable controversy has taken place regarding the indelibility of tattoo marks. Tardieu, whose investigations were very thorough and far-reaching, believed that it was possible to entirely get rid of extensive tattoo marks, and found that it

was the custom for criminals in French prisons to resort to blisters, acids, and other escharotics, with more or less success. It would appear from his investigations that deposits of India ink are much more indelible than vermilion, or other pigments, but even they would occasionally disappear without any systematic attempt at removal. A French criminal referred to by Tardieu effectually removed within six days very extensive marks from his body by means of an application of a paste of acetic acid and lard, and afterward they were rubbed with potash and finally with dilute hydrochloric acid. Tardieu, who experimented, found that if the paste were left on for a day there would be some detachment of the cuticle, and that if the potash were used the second day, and the parts rubbed five or six times, such application would be followed on the third day by the formation of a crust which finally fell off, leaving a partial obliteration. Successive crusts, which were undoubtedly due to a more or less deep destruction, were removed, and at last it was found that the parts beneath were without any remaining pigment.

Taylor, on the other hand, is of the opinion that deep tattoo marks cannot be effaced, in which conclusion he is opposed by the writer to whom reference has just been made, as well as by Casper and Hutin.

Casper found that out of 37 persons examined the marks had become effaced in 6; Hutin, of 509 examined, disappeared in 47; Tardieu, of 76 examined, effaced in 3—over nine percent. of the whole. In the famous Tichborne trial, evidence was given that both Roger Charles Tichborne, the heir, and the man called Arthur Orton had been tattooed. Now Tichborne's tattoo was R. C. T., and Arthur Orton's was A. O. On the arm of the claimant there were no tattoo marks at all, but there were two round depressed scars on the left wrist about the size of a shilling, and suggestive of the tattoo marks as A. O. These scars had evidently been produced by escharotics. Of course excision of tattooed wounds is an easy possibility.

HANDWRITING.

Identification by means of handwriting is largely a matter of comparison and natural proof, and I will only refer to it briefly. Attention, however, must be called to the peculiarities of style, the formation of habits, and the variation of chirography under different circumstances. When once the automatic habit of writing is acquired, there is usually very little difficulty in determining by comparison the correspondence of one given example with another; but when through disease the volitional impulse is interrupted, a very decided change occurs, which may to a certain extent confuse the examiner. Mere tremblings need not be considered, but through mental disease or certain organic nervous affections a very material change in style and letter formation is a familiar feature; among the sane, sustained efforts at deception are almost impossible, and different parts of the same letter, as well as an inspection of letters written at different times, will reveal peculiarities which are the result of acquired habit. It will be necessary to determine sometimes whether a person has written with his right or left hand, and it must not be forgotten that it is possible, as we know in the cases of writer's cramp, for

persons to educate themselves to write with the unaffected extremity, the result being often a legible and clear production with more or less change of style.

FINGER AND FOOT IMPRESSIONS.

For the establishment of the identity of a criminal a careful examination should always be made of the papers handled, window-panes, and china and glass ornaments, or, in fact, any other object which may receive an impress from his more or less greasy fingers, at the place of commission of the crime. By oblique light there will sometimes be no difficulty in finding upon the polished window-pane a faint though perfect imprint, which can afterward be strengthened and made the subject of a permanent record. For this purpose the method contrived by Forgeot (publications of the *Laboratoire d'Anthropologie Criminelle*, of Lyons), which consists in the application of common ink or some aqueous pigment which will adhere to the parts that are not greasy, may be tried; or the glass may be subjected to the vapor of hydrofluoric acid. Forgeot has shown that even pieces of paper which have been touched by slightly greasy hands will bear the imprint of the fingers, and the most delicate markings may be brought out after treatment with ordinary ink, and these used as a negative with good results. In exceptional cases the finger-marks may be made to give lithographic impressions.

Galton (*Finger Prints*, London, 1892) refers to the comparison of these markings with those which are obtained by making the suspected person press his thumb and fingers upon transfer-paper, the impression being subsequently transferred to stone, thus correcting the impression, which should be reversed if direct contact were made.

The value of finger impressions as a proof of identity is certainly one that has not been over-exaggerated. Galton says: "So far as the proportions of the patterns go, they are *not* absolutely fixed, even in the adult, inasmuch as they change with the shape of the finger. If the finger is plumped out or emaciated, or variously deformed by usage, gout, or age, the proportions of the pattern will vary also. Two prints of the same finger, one taken before and the other after an interval of many years, cannot be expected to be as closely alike as two prints similarly made from the same woodcut. They are far from satisfying the shrewd test of the stereoscope, which shows if there has been an alteration even of a letter in two otherwise duplicate pages of print. The measurements vary at different periods, even in the adult, just as much if not more than his height, span, and the length of his several limbs. On the other hand, the numerous bifurcations, origins, islands, and inclosures in the ridges that compose the pattern are proved to be *almost beyond change*. A comparison is made between the pattern on a finger and one on a piece of lace; the latter may be stretched or shrunk as a whole, but the threads of which it is made retain their respective peculiarities. The evidence on which these conclusions are founded is considerable, and almost wholly derived from the collections made by Sir W. Herschel, who most kindly placed them at my disposal. They refer to one or more fingers, and in a few instances to the whole hand, of fifteen persons. The intervals be-

fore and after which the prints were taken amount in some cases to thirty years. Some of them reach from babyhood to boyhood, some

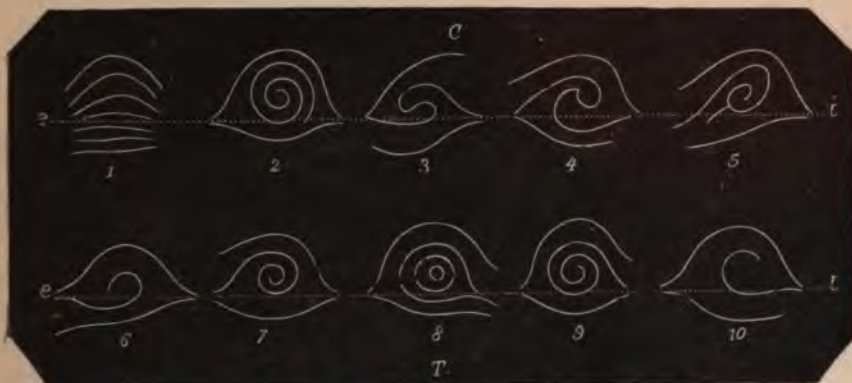


Fig. 39.—Schematic figure showing the different thumb-tip types of Galton and the disposition of the papillary lines. The capitals, *C* and *T*, respectively indicate the curved lines (*C*) and the transverse lines (*T*); the small letters, *e* and *i*, correspond to the external and internal sides of the last phalanx. 1, First type (primary type); 2, second type (*Cei*, *Tei*); 3, third type (*Ce*, *Ti*); 4, fourth type (*Ci*, *Te*); 5, fifth type (*Ci*, *Ti*); 6, sixth type (*Cei*, *Ti*); 7, seventh type (*Ci*, *Tei*); 8, eighth type (*Ce*, *Te*); 9, ninth type (*Ce*, *Tei*); 10, tenth type (*Cei*, *Te*). (Testut.)

from childhood to youth, some from youth to advanced middle age, one from middle life to incipient old age. These four stages nearly include the whole of the ordinary life of man. I have compared altogether some 700 points of reference in these couplets of impressions, and only found a single instance of discordance, in which a ridge that was cleft in a child became united in later years. Photographic enlargements are given in illustration, which include between them a total of 157 pairs of points of reference, all bearing distinctive numerals to facilitate comparison and to prove their unchangeableness. Reference is made to another illustrated publication of mine, which raises the total number of points compared to 389, all of which were successful, with the single exception above mentioned. The fact of an almost complete persistence in the peculiarities of the ridges from birth to death may now be considered as determined. They existed before birth, and they persist after death, until effaced by decomposition."

Fig. 40.—Impression of the right thumb—schematic. (Testut.) 1, Curved lines; 2, transverse lines; 3, intermediate lines; *C*, the highest of the curved lines; *T*, the lowest of the curved lines; *e i*, external and internal sides of the thumb.

A definite and constant series of patterns is found. (See Fig. 39.) These consist of ridges and depressions, and the last phalanx of the thumb contains in its space between the parallel ridges "a compact little system of its own, variously curved and whorled, being a fictitious resemblance to an eddy between two currents." (See Fig. 40.)

Galton gives examples to show how the outlining is performed, and some of the patterns which are characteristic. He says: "Outlines fall

for the most part into nine distinct genera, confined by the relative direction of the divergent ridges that inclose them." He divides his classification with reference to the existence of arches, loops, and whorls. "In the arches there is no pattern, strictly speaking, for there is no interspace; the need of it being avoided by a successive and regular broadening out of the ridges as they cross the bulb of the finger. In loops the interspace is filled with a system of ridges that bends back upon itself, in which no ridge turns through a complete circle. Whorls contain all cases in which at least one ridge turns through a complete circle, and they include certain double patterns which have a whorled appearance."

I append one of his plates, which has been reproduced by Testut, which may serve as a guide for examination.

THE SIGNIFICANCE OF FOOTPRINTS.

Sometimes footprints are the only traces left by a murderer, and will alone lead to the identity of the assassin. Much attention has been paid, especially by Ogston, to the impressions that are often found in the soil near the place where the deed has been committed. Putting out of the question certain scars and other peculiarities that may be subsequently compared with the foot of the suspected person, and devoting more attention to the footmark itself, we may assume that, according to Mascar and

Fig. 41.

most others, the print in the ground is smaller than the foot which made it. This is in variance with the popular idea that the impression in the ground is equal if not larger than the foot that made it, and Caussé holds to this view that the impression is usually larger. It has been shown that the action of the individual can be somewhat determined—that is to say, whether he was standing, walking, or running—from the depth and extent of the marks.

Fig. 41 represents the method adopted by Caussé (*Annales d'Hygiene Publique et de Médecine Légale*, 2d series, vol. i., 1854) for the purpose of identifying the footprints of incriminated persons. The line *A B* is drawn between the internal part of the curve of the heel and the prominent point at the metatarso-phalangeal articulation. This line is divided by others equidistant at right angles from the first, leaving a number of divisions which serve as guides for measurement and for tracing the internal border of the footprints. It will be seen by Fig. 41 the variations that may take place under different circumstances, and this may be considered in every way to be a safe and certain guide, unless the bottom of the foot is so smeared with blood as to prevent the recognition of its contour.

It is often of the utmost importance that a mold should be taken of the footprints, and when one is found that is the most satisfactory, the method of Hougilon may be resorted to. This consists in heating the impressed ground to 220° F., or more, which may be done by holding over it a shallow pan containing burning charcoal, or more quickly and simply by the use of a painter's benzine lamp, and then dusting the heated impression with ground paraffine. When the soil is cool the paraffine may be removed for a mold of plaster of Paris, or electro-metallurgical reproduction.

RIGHT- AND LEFT-HANDEDNESS.

A consideration to be regarded is the question of right- or left-handedness; the movements of the suspected individual should therefore be closely watched. The degree and situation of a possible asymmetry should be determined, and his boot-heels inspected—in fact, it is always wise to closely examine the clothing of a prisoner with reference to its condition, fit, and newness. A trap into which the prisoner unwarily falls may be arranged by asking him suddenly to hold up his *right* or *left* hand, and he will usually not consider the result. A case is referred to in which Sir Astley Cooper was called as a witness where the prisoner was pressed to admit that he was left-handed, but denied the accusation. "When called upon, however, to plead to the indictment, he unconsciously held up his left hand."

GENERAL SUGGESTIONS AS TO EXAMINATIONS.

The conduct of the examination of a suspected person should be thorough and painstaking. The memory of past occurrences should be investigated and the consistency of answers noted. His body should be carefully gone over, and, if possible, an outline figure should be provided upon which the location of body-marks are noted, with measurements and explanatory text. Not only is every external part to be inspected, but evidences of mutilation or disease alteration should be looked for, and the presence of artificial pigments, powder grains, tattooing, the scars of venereal and other sores recognized. The teeth must be separately looked at, and their appearance, condition, and the fact recorded whether and how they are filled.

If possible, a photograph is to be secured, and it is best to have two, one of the full face and the other of the profile. The photographer should carefully avoid any sources of distortion; lighting the face uniformly, and avoiding the forward projection of the upper or lower half. If there be any bodily peculiarities, or extensive tattooing, a photographic representation should be made. As a rule, old photographs, carelessly taken, are not of much use, and are often unreliable for positive identification. I have seen three pictures of one New York criminal taken at different times, but all during a criminal career of adult life, which are utterly dissimilar. At the Prefecture in Paris, although photographs accompany the identification cards, very little value is placed upon their help except as an auxiliary aid.

In these days of progress, criminal registry is becoming so general that some notice should be made of the admirable work of Bertillon.

M. Alphonse Bertillon has invented an admirable system, which has been adopted by the French Government and has found its way to this country, being in vogue in Boston and Chicago, and may serve to fix the identity of criminals coming from these places, although it is not practiced as systematically as in France. In ten years he has made measurements of no less than 100,000 criminals, preserving the results and classifying them so that it is possible to accurately hit upon the required description of any suspected person, and I have myself seen habitual criminals or recedivists positively identified at the Prefecture after a few minutes' search.

It is Bertillon's method to tabulate the measurements, together with a description of certain physical appearances, and a front and profile photograph, which are recorded upon a card which is filed away with others within easy reach.

There are four chief measurements: (1) the head length; (2) the head breadth; (3) the middle-finger length; and (4) the foot length—the measurements of these parts being found to be more constant than others.

These four are still further subdivided into "small," "medium," and "large," so that there are in all eighty-one principal headings which may include the case of the particular prisoner. There are still further subdivisions of these primary headings, the same triplex classification being carried out. The height of the trunk is made the basis of one division, while the ear measurements are recorded so that its length and breadth are taken, the height, the span, and cubit forming others. The color of the eye is determined, and is classified under seven headings, and finally the records are grouped and subdivided, and upon each body-marks and special appearances are detailed.

Bertillon's classification of appearances presented by the ear includes the variations presented in Fig. 60. He also refers to the configuration of the nose and the characteristics of the forehead, and these are portrayed in Figs. 42–59. According to this investigator the ear undergoes very little change. Contorted and swollen ears often indicate the existence of previous insanity.

It can be seen that numerous classifications are possible, and it is comparatively easy to nearly approximate the exact description of any particular person.

The possibilities of this admirable system are unlimited, and doubtless when insurance companies subject their applicants to some general form

Fig. 42. Concave-elevated.

Fig. 43. Concave-horizontal.

Fig. 44. Concave-descending.

Fig. 45. Rectilinear-elevated.

Fig. 46. Rectilinear-horizontal.

Fig. 47. Rectilinear-descending.

Fig. 48. Convex-elevated.

Fig. 49. Convex-horizontal.

Fig. 50. Convex-descending.

Noses Classified according to Bridge and Base. (Bertillon.) By permission of S. S. McClure Co.

Fig. 51. Receding forehead.

Fig. 52. Intermediary inclination.

Fig. 53. Vertical inclination.

Fig. 54. Height of forehead: Small.

Fig. 55. Medium.

Fig. 56. Great.

Fig. 57. Breadth of forehead: Small.

Fig. 58. Medium.

Fig. 59. Large.

Classification of Foreheads. (Bertillon.) By permission of S. S. McClure Co.

of measurement at the time of taking policies, there will be no likelihood of conspiracies for the purpose of illegally obtaining premiums.

Drs. Smart and Greenleaf, of the Medical Department of the United States Army, have adopted a system which has its advantages, although it is less reliable than the Bertillon system.

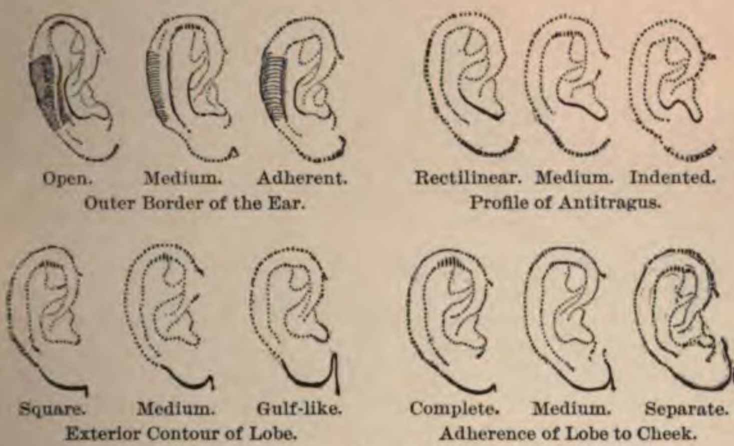


Fig. 60.—Some Classifications of the Form of the Ear. (Bertillon.)

According to Smart and Greenleaf, desertions from the United States army are believed to greatly exceed deserters who are apt to repeat their offense. It is believed to be possible to detect such "repeaters" if the body-marks of all recruits are recorded, if all deserters are recorded, and if all recruits are compared with previous deserters. In like manner men discharged for cause should be excluded from reëntry. The originators of this plan do not believe in the value of Bertillon's method before courts-martial, because of possible inaccuracies and allowable errors, but only as a confirmatory proof when following coincident indelible marks, when height, age, and hair fairly correspond. In other words, Bertillon's collateral evidence is practically primary evidence. Smart and Greenleaf use for each man an outline-figure card, giving anterior and posterior surfaces, divided by dotted lines into regions, which are filed alphabetically at the Surgeon-General's office at Washington. As a man goes out for cause, or deserts, his card is filed separately, and the cards of recruits are compared with the last file.

"To make this comparison, a register in two volumes is opened, one for light-eyed and one for dark-eyed men. Each is subdivided into a fair number of pages, according to height of entrance, and each page is ruled in columns for body regions. Tattooed and non-tattooed men of similar height and eyes are entered on opposite pages. Recruits without tattoos are not compared with deserters with tattoos; but recruits with tattoos are compared with both classes. On the register, S., T., B., M., etc., are used as abbreviations for scar, tattoo, birth-mark, mole, etc. One inch each side of recorded height allowed for variation or defective measurement. When probability of identity appears, the original card is used for comparison."

IDENTITY AND SURVIVORSHIP.

BY

BENJAMIN N. CARDOZO.

It would seem, to the world of to-day, a strange, if not incredible, notion that there was a stage in the growth of law when personal identity was a problem of very limited concern. Yet it was so. That problem has not always existed to tax the energies of litigants and to perplex the minds of courts. Only with the gradual development of law has it emerged as a legal concept of permanent and paramount importance. It is a concept that had but little place in the most primitive stages of legal growth, for the identity of the individual was absorbed in the identity of the tribe. Vengeance, to be sure, was not unknown; vengeance, prompt and sharp and merciless, was exercised then as now; yet it was vengeance not merely on the perpetrator of the deed, but on his kinsmen, his family, his clan. There was no thought of this as a punishment vicarious in its nature. It did not present itself to those ages in such a light. The individual had no life apart from his clan; he had no legal status except beneath its sheltering care; and a sense of solidarity, unknown to future times, made each the agent of the other and each the guardian of all.*

It is a slow and in many ways a curious history that marks the rise of this concept of personal identity from its crude beginnings to the commanding position which it holds to-day. There seems, indeed, to have been a sort of intermediate stage where the identity of the offending person was confused with the identity of the instrument through which the offense was perpetrated. It must be borne in mind throughout that the unit of society in primitive times is not the individual, but the family or clan.† Community of property, or rather perhaps the absence of any definite notion of property at all, tended still further to subtract from the individual's importance as the bearer of rights or the subject of duties. And so it is that private wrongs were wont to engender as their consequences, not merely private vengeance upon the offender, but vengeance upon his clan. The personality of the individual was merged in the personality of his tribe. The search after the identity of the offender was forgotten in the pursuit of the clan from which his station in the community was derived. And so we find that the first dim awakening of a sense that the individual offender should bear the

* H. S. Maine, *Ancient Law*, p. 122.
† *Ibid.*, pp. 121, 178.

burden of his own guilt was due to the desire of the clan to avert from itself, and to cast upon its guilty member, the consequences of his crime.* By yielding up the offender to the vengeance of his accuser, or perhaps by sacrificing him to the anger of the gods, the family purged itself of blame. It was felt that the wrong of the offender was the wrong of the clan. It was felt that the accuser might fairly exact reparation of the clan. It was felt that the divine indignation would justly be visited on the clan; and the first trace of a weakened sense of tribal solidarity, the first trace of a growing notion of individual responsibility, the first trace of a distinct recognition of personal identity as a permanent legal concept, may be found in the effort to absolve the tribe, to cleanse the community, from the crime and the taint of its guilty member.

And yet even here the effort was not so much to insure the punishment of the real offender as to insure the punishment of somebody. It was not so much an effort to fasten the crime upon the guilty wrong-doer as to save and purify the clan from the threatened vengeance of men or of the gods. It was an effort to preserve intact that corporate personality in which the identity of the individual was deemed to have been merged. The controlling necessity was that the tribe should be purified; and the divine power might well be trusted to single out for destruction no other but the true offender. The traces of this notion may be seen in the ordeal, which once formed a part of the judicial system of every people, whether of the East or West, and which in its essence "was a passive appeal to the power of nature as the voice of God."† In England, even in the twelfth century, an accusation by the body of the country, preferred on common fame or general suspicion, was "practically equivalent to a conviction, subject to the chance of the favorable termination of the ordeal by water." If the ordeal failed, the accused person lost his foot and his hand. If it chanced to succeed, he was nevertheless banished. Accusation was thus equivalent to banishment at least, and the survival of the ordeal only mitigated the punishment of the suspected criminal.‡

That old notion of the potency of certain tests to indicate the divine judgment as to the identity of an offender lived on, indeed, for generations to come, and under the most divergent forms of law. Some of us may recall the account that is given by Mr. Lowell of the trials for witchcraft among our ancestors of two centuries ago.§ It was suggested that no witch could repeat the Lord's Prayer, and the court directed that the test be made, but informed the jury that they were not in the least measure to regard it, "because it was not legal evidence." The days of the old ordeal had not been yet forgotten. The assumption that the minds of the jurors, abstracting from the case every item of irrelevant proof, would be swayed solely by the directions of the court, strikes us to-day as grimly grotesque in its hypocrisy; yet perhaps it is not necessary that we should turn to the records of a bygone age to meet with parallel instances of the blindness of the law.

It was a step in advance of the old trial by combat when the law required proof, though of an arbitrary and illogical kind, as to the identity

* Lightwood, *The Nature of Positive Law*, p. 163.

† George Neilson, *Trial by Combat*, p. 1.

‡ 1 Stephen, Hist. Crim. Law of England, 252; Assize of Northampton, A.D. 1176, Stubbs' Charters, 145–150; *Hurtado* vs. *California*, 110 U. S. 516, 530.

§ J. R. Lowell, *Among My Books*, vol. i., p. 104.

of the person accused of crime. For a long time it indulged in certain presumptions of guilt which it treated as conclusive, and which no evidence would be permitted to rebut. A man, for example, who was found standing over a dead body with a bloody knife in his hand was deemed estopped from denying the charge of murder. The inmates of a house in which a man had been found murdered in the night, if they had raised no hue and cry, and could show no wounds or other marks of violence sustained in defending the dead man from his assassin, were conclusively presumed to have caused his death.* But even these presumptions, crude as they are, marked a certain advance in the growth of legal thought. The circumstances from which guilt was inferred had a certain probative force—not that conclusive force which was ascribed to them, but still a certain force as tending toward the conclusion of a defendant's guilt. They were steps in the direction of requiring *proof* of the identity of the offender, even though the proof was weak, and the inference of guilt that was drawn from it unauthorized. The necessity that punishment should be visited on the real offender—the necessity, too, that something more than chance should determine who the offender was—that necessity had at last made itself manifest to the consciousness of the race.

It should be noted, indeed, that when the clan had been, as it were, resolved into its elements, and individual identity had become a familiar concept of the law, the concept was applied with a simplicity, a rigor, and a literalness which are unknown to later days. Back of the mere instrument by which a wrong is done, developed systems of law look to the intelligent agent by whom the instrument is directed. Primitive law, however, knows no such distinction.† It recognizes a guilt in slaves, in animals, even in lifeless things. It yields up to the accuser the tree which has fallen on him, the sword which has wounded him, the beast which has trampled on him. They are his, to satisfy his vengeance upon them; they are given up to destruction; it is the *noxæ deditio.*‡

And so we may say, I think, that the problem of identity in early law is a problem of physical rather than personal identity. It is a search after the hand that did the wrong; it is not a search for the mind that willed it. In all this, early law is but true to its vindictive origin. "All the law in the world has," in the words of Ihering,§ "been obtained by strife;" and the passion of revenge, satisfying itself even upon inanimate things, has been the final source and sanction of the peace and the order of the world. But the truth which I desire to enforce is that the problem of personal identity as it presents itself to-day is a problem which has an historic past and which has met with different answers at different stages in the growth of law. The gradual recognition of the truth that the law must regard the intelligent agent rather than the passive instrument and the gradual demolition of arbitrary presumptions have been the work of centuries of legal progress. If it be possible to-day to treat questions of identity by the methods, for the most part, of a rational logic, it must not be forgotten that the problem was once a very different problem, and the mode of its solution a very different mode.

* Forsyth, *Trial by Jury*, p. 167. Bracton, lib. iii., c. 18.
† O. W. Holmes, Jr., *The Common Law*, p. 10.
‡ *Ibid.*, p. 19.
§ Ihering, *The Struggle for Law*, p. 1; and see O. W. Holmes, Jr., *The Common Law*, p. 2.

Adequately to present the possible phases in which the question of identity may arise before a court, and the possible means by which that question can be solved, would be to catalogue all the conceivable instances in which the presence or absence of a given fact may be deemed to confirm or to weaken the hypothesis of the identity of two given individuals. Far as we have gone of recent years in basing our law of evidence upon the canons of inductive logic, a survey of the decisions on this topic must leave one impressed with the belief that problems of evidence may, indeed, be problems of logic, but they must always be something more as well. "The life of the law,"* it has been truly said, "has not been logic; it has been experience;" and experience in last analysis is the final test of the validity of proof. We cannot divorce the rules of law from the life, the emotions, and the history of men. We cannot explain the causal relation which we feel to exist between two phenomena except by reference to the experience of the race that the two have in practice been found combined. We cannot give an intelligible explanation of the compelling force exercised by a given circumstance upon our minds except by our knowledge that in the ordinary course of events, in the ordinary life of the race, in the ordinary experience of mankind, a given circumstance is wont to accompany another, and so in the language of the law is deemed to prove it. The content of all rules of evidence is given by experience; and logic can never do more than to classify, and perhaps to limit or restrain them.

We shall feel this, I think, if we attempt to give any strictly logical explanation of the decisions which illustrate this problem of personal identity. We shall feel that the content of the rule of evidence is so dependent on experience that it resists our efforts to formulate it as a rule of orderly, coherent thought. And the question is further complicated by the fact that personal identity is itself a symbolic term; that identity is known to us only by its external manifestations, and yet is felt to be something separate and distinct from those manifestations by which it is revealed.

To any one but to a man's own self, his identity may be said to be a complex notion in which his physical and mental traits, and his past history and experiences in so far as they are known, may be deemed to be the predominant elements. It is manifest, therefore, that as identity can be known to us only as a man's qualities or experiences are known to us, proof of any element that goes to make up our notion of identity will, in this connection, be material and relevant. If the identity of a person, either with some one known to us in time past or with the perpetrator of a given deed, be a fact in issue, it will accordingly be permissible to prove:

(*a*) Any fact that shows the coincidence (or the contrary) of the general appearance of the one with that of the other.

(*b*) Any fact that shows the coincidence (or the contrary) of the physical peculiarities of the one with those of the other.

(*c*) Any fact that shows the coincidence (or the contrary) of the mental peculiarities of the one with those of the other.

(*d*) Any fact that shows the coincidence (or the contrary) of the history or experiences of the one with those of the other.

* O. W. Holmes, Jr., *The Common Law*, p. 1.

(*e*) Any fact that in the ordinary course of events renders it probable that the person before the court is the person by whom an act in issue has been perpetrated; and all facts that would in common experience precede or that would in common experience follow the act in issue, such as motive, preparation, or the possession of the fruits of crime, are, within the meaning of this principle, to be deemed to be relevant.

The foregoing analysis will suffice in itself to show the complexity of the problem; but the question is further complicated by the fact that those external qualities by which identity is known are not really of the essence of identity; that the qualities may change in their entirety, and the identity may still subsist. If, for example, we know the present traits and the past history of A, and the present traits and the past history of B, and if complete agreement exists, the process is mainly one of comparison, though the warrant for the conclusion of identity results from the general experience of the race that complete coincidence of traits and of history is never found, as between different persons, to exist. On the other hand, if we simply know the present traits of A and the past traits of B, and if disagreement, partial or complete, exists, the main question will be the likelihood that such changes should have occurred were the persons in reality the same; and any fact that in the ordinary course of events would tend to cause or to prevent such changes will thus become relevant. A case which excellently serves to illustrate the difficulties of such inquiries and the application to them of the teachings of medical science is quoted by Dr. Beck* from the commentaries of Zacchias: "A noble Bolognese, name Casali, left his country at an early day and engaged in military pursuits. He was supposed to have lost his life in battle, but after an absence of thirty years returned and claimed his property, which his heirs had already appropriated to themselves. Although there were some marks which appeared to identify him, yet the change in appearance was so great that none who remembered him were willing to allow that this was the individual. He was arrested and imprisoned. The judges were in great doubt, and consulted Zacchias whether the human countenance could be so changed as to render it impossible to recognize the person. This distinguished physician, in his consultation, assigns several causes which might produce such an alteration: as age, change of air, ailments, manner of life, and the diseases to which we are liable. Casali had departed in the bloom of youth; he had entered on the hardships of a military life, and if the narrative of the individual in question is to be credited, he had languished in prison." All these causes, it was conceived, might produce a great change in the countenance, and render recognition difficult, if not impossible.

It is because traits of body or of mind are those with which in the main we associate a man's identity, and because medical science can bear the most important witness to the possibility of the effacement of traits, whether bodily or mental, that questions of identity have found a place in treatises on medical jurisprudence. It is very manifest, however, that their connection with medicine is rather the result of the accidents of given cases than of any inherent union between the two, or of any necessary dependence of the one upon the other.

* Beck's *Medical Jurisprudence*, vol. i., p. 659.

[illegible]

[illegible] How [illegible] well [illegible] in any [illegible]

[illegible] which [illegible] Martin [illegible] from his [illegible] the [illegible] sisters, his uncle, [illegible] acknowl- [illegible] years [illegible] in the in- [illegible] suspicions as [illegible] having [illegible] though sub- [illegible] acquaintance [illegible] and position he [illegible] of his mar- [illegible] and numberless [illegible]—all these were stated [illegible] dispute the defend- [illegible] witnesses that testified upon the [illegible] thirty and forty deposed [illegible] Martin Guerre, that they had known [illegible] that they were perfectly [illegible] and that they moreover [illegible] asserted by certain scars and [illegible]

[illegible] witnesses deposed positively [illegible] Arnaud du Tilh of Sagias, and was commonly called [illegible] perfectly acquainted with his person, air, [illegible] The rest of the witnesses, to the number of sixty or upward, [illegible] there was so strong a resemblance between the two persons that it was impossible for them to declare whether the accused was Martin Guerre or Arnaud du Tilh. Nearly all the witnesses, however,

* Wharton on Evidence, vol. i., p. 17.
* Ram on Facts (3d Am. ed.), p. 400.

agreed that Martin Guerre had two scars on his face, that his left eye was bloodshot, the nail of his first finger was grown in, that he had three warts on his right hand, and another on his little finger; and all these marks were found on the accused.

From a judgment of conviction before the criminal judge of Rieux, an appeal was carried to the parliament of Toulouse; and that tribunal was so perplexed by the conflicting testimony adduced before it that the reversal of the judgment of the lower court seemed highly probable. It was only the sudden appearance of Guerre himself upon the scene, and the direct comparison of the two men by their relatives and by the court, that dispelled the doubts of the judges, and led to Arnaud's conviction of the crime with which he had been charged.

In this remarkable case nearly every element by which the identity of a person can be established was proved by clear and cogent and unhesitating proof. Many of its features are so extraordinary as to suggest at least a doubt with reference to the sincerity of the impostor's witnesses. That a man should fraudulently personate another in an action in the courts, that he should so closely resemble the missing man as to cause the relatives of the latter to testify in the claimant's behalf, that he should even in some way have so acquainted himself with the life and history of the absent man as to withstand a searching examination directed to these points,—all this in itself is marvelous enough. But that for three years, in all the relations of daily life, in all the manifold incidents by which character and temperament are revealed, with all else that goes to make up our notion of identity—that in all these details the impostor should have satisfied the doubts of those who had been closest to the missing man, is a fact that must tend to inspire renewed convictions of the fallibility of every form of proof.

It is related that the members of the parliament were somewhat incredulous as to the possibility of practicing a deception upon the wife of the missing man for so long a period of time; and many of them were disposed to believe that the lady had wearied of her single life, and were inclined to adjudge her a party to the scheme; but her character, it is said, in point of modesty and prudence, and the fact that many of the closest relatives of Guerre had been similarly misled, caused the parliament to resolve their doubts in her favor and to acquit her of the charge of any intentional wrong. Guerre himself, according to the report, was less charitable in his judgment, and maintained that a wife could not thus be imposed upon, "unless she had secretly cherished an inclination to be deceived."

A case of much more recent date, which excited popular interest and discussion to a marked degree, and which seems to sum up within itself most that can be said upon the problem of identity in its relations to legal medicine, is the famous case of the claimant to the Tichborne estate. Almost all those circumstances from which identity may be inferred—almost all those elements of which our notion of identity is compounded—were there testified to by those witnesses, of all the world, whose testimony on such a topic might most implicitly be believed. The mother of the absent man, the family solicitor, seventeen servants of the Tichborne household, and a host of other witnesses—all swore that the claimant was the real Sir Roger. The charge of Chief-Justice Cockburn presents with rare ability the difficulties that attend the solution of prob-

[illegible] of this kind and [illegible] that even the most direc
[illegible] mistake. He is spea
[illegible] heir to the est
[illegible] claimant as in reality
[illegible] he asks, "which ought to
Lady Tichborne [illegible] the defendant as her
the defendant [illegible] had presented the outward a
[illegible] Were there not cir
[illegible] hesitate, and certainly not de
[illegible] asking, in the words of the Patr
[illegible]

That maternal instinct, which it was urged, outweighed
opposing witnesses, outweighed the weightiest arguments
[illegible] Lord Cockburn clearly saw, an instinct at
[illegible] he says, "an impulse of nature stronger than human
[illegible] something which carries you irresistibly
particular [illegible] It is the product of long and close ass
watching [illegible] night, and for year after year: "it
being familiarized by daily habit with everything that ap
personal identity—features, form, gestures, everything which
the sum total of identity."

"We must not allow ourselves," said the court, "to be ca
by declamatory commonplace about a mother's instinct, but
to see how far we can trust to the mother's judgment. We sh
with all due respect to the opinion of the mother; we shoul
a circumstance calculated to weigh strongly in the scale; but
viction, having taken into account the large range and vari
which we know and which the mother did not know, is that s
wrong, no appeal that is made to your feelings, or addresse
the name of the departed mother, ought to influence your
Take it as a most important circumstance in the case, but not
sive as the learned counsel would make it. If it were so, wh
all this long and protracted inquiry?"

And yet, in spite of certain points of diversity, which are r
charge of the court, the claimant, so far as physical traits were
went far toward satisfying the most exacting tests. Both
appearance and in certain physical peculiarities, the resembla
not complete, was at least sufficiently marked to forbid the l
tion of the claim. The collapse of the plaintiff's case and his
conviction for perjury, as we shall later have occasion to not
the place which mental traits occupy in our notion of identi
which, if less prominent, is perhaps more constant and detern
that which is occupied by any traits of the physical organism

But the Tichborne case is only a single instance of a typ
numberless examples may be found. Cases involving sim
though on a less imposing scale, are scattered through all t
and reports.* There is the well-known case of *The People* v
a prosecution for bigamy—where twelve witnesses testified to

* Some curious cases may be found cited in the opinion of Mason, J.
The People, 3 Parker's Crim. Rep. 401, 446. See also an article in the
Journal of September 28, 1872, p. 230.

† Ram on Facts (3d Am. ed.), p. 412.

of the defendant, apparently from long and intimate personal acquaintance. His innocence was established by the equally positive testimony of six witnesses, and more particularly by evidence as to the absence of a distinctive scar. There is the equally well-known case of Luther Hause,* where a young man personated the part of a son who had been lost in childhood, and took up his abode for a long period of time as an acknowledged member of the household. Nor is there any lack of instances where, after the conviction and execution of supposed criminals, upon the most direct and unfaltering evidence of their identity, the appearance of the real offender has demonstrated anew the infirmity of every form of proof. The poor vagabond who in 1727 was put to death at York,† protesting vainly that his identity had been mistaken, while witness after witness with confident emphasis denounced him as Geddely, the thief, found, in the fullness of time, a tardy vindication—long after his prosecutors had hurried him out of the world. There is a grim pathos in the narrative of the trial of Shaw, who was executed for murder in 1721. Years afterward, when the poor fellow's body had been resting quietly in his dishonored grave, the truth of the case came out. And so in token of his innocence they fastened a flag upon the grave; they set the flag flying in the wind; and that was the way that they undid the wrong.‡

Yet it is easy to exaggerate the number and even to exaggerate the importance of cases of this kind. The sacrifice is one that every system of remedial justice must involve; and it will not do, fastening our gaze upon the instances of error, to forget the manifold instances where the right has been attained. Conspicuous cases of doubt or of injustice have so fixed the popular attention as possibly to engender a belief in the uncertainty of inquiries as to identity, which almost outruns the distrust that the difficulties of the problem might reasonably inspire.

Impressions of general resemblance have, however, so often proved themselves at fault that courts have been eager to discover some surer token by which identity might be revealed. They have found in evidence of special traits or peculiarities of feature or of form a test by which the vagueness of general impressions might safely be corrected.

(b) **Physical Peculiarities.**—Physical peculiarities have been a most common, and in many respects a most satisfactory, means for the solution of problems of identity; yet even here, as we have already seen, the possibility of error exists. In Guerre's case, as has been shown, the correspondence of certain physical peculiarities of the missing man with those of the impostor was most striking and complete. In the Tichborne case, too, "the claimant gave proof of a fish-hook wound on the eye; of a mark of bleeding on the ankle; and of a peculiar scar on the head, which a hair-dresser swore had been seen upon the head of the real Sir Roger." Yet due allowance being made for these and other conspicuous instances of error, the existence of any distinctive physical trait, when coupled with a general impression of resemblance, not only affords, to say the least, the strongest corroborative proof, but frequently furnishes the only data from which a witness may be enabled to recall the personal appearance of a man who has been hastily observed.

(1) *Physical Marks.*—Congenital marks, marks of tattooing, and the

* Ram on Facts (3d Am. ed.), p. 432.
† *Ruloff* vs. *The People*, 3 Parker, 401.
‡ Ram on Facts (3d Am. ed.), p. 453.

scars left by wounds and by disease have been repeatedly employed in cases of disputed identity as instruments of proof. In the case of Salomé Miller,* who was held as a slave in Louisiana, and who brought suit for her liberty in the courts of that State, the existence of two small *nævi maternæ* upon the inside of each thigh was the medium by which her identity was established and her liberty secured. In the Hoag case,† as we have seen, the innocence of the accused defendant was demonstrated by the absence of a scar which a cut with a scythe was known to have left upon the foot of the man for whom the defendant was mistaken; yet it is to be noted that in the existence of a scar upon the forehead the physical peculiarities of the two were proved to coincide. The Hanse case‡ is a still more curious instance of the frequent correspondence of marks of violence upon different men; for the impostor exhibited numerous scars which agreed in the most striking manner with the scars of the missing son. From the French tribunals comes the record of the case of a man named Lesurques who was convicted and executed upon a charge of murder in 1794; and not only did the real murderer, who was subsequently discovered, resemble Lesurques in general form and feature, but on the forehead and the hand of both a similar scar was to be found.§

Artificial marks have been equally common as a medium of proof. The Tichborne trial for perjury again supplies a pointed illustration. It was shown by a number of witnesses that Sir Roger had upon the inside of his left forearm certain tattoo marks of a blue color, representing a cross, a heart, and an anchor. Lord Bellew, a school-fellow of Sir Roger, testified that he had seen the symbols on Roger's arm, and that he himself had imprinted there in addition the letters R. C. T. The defendant not only could show no similar marks upon his person, but he denied that he had ever been tattooed at all. The proof of the existence of these emblems upon the real Tichborne heir at the time when he was lost at sea in April, 1854, was so abundant and convincing as to contribute doubtless in no slight degree to the ultimate detection of the fraud. "Unless we are prepared to admit," says Dr. Taylor,‖ "that a man can be tattooed and have no knowledge of the fact, and having been thus unconsciously tattooed, that all the marks had disappeared before he saw them, it is impossible that this claimant could have been the Roger Charles Tichborne, the heir to the estates."

In an early case in this State,¶ the identity of a man who was found murdered was established in the main by the presence upon the leg of the initial letter of his name; and the courts of some States have even gone so far as to permit the forcible inspection of distinctive marks for the purpose of identifying a suspected criminal. In a case, for example, that came before the courts of Nevada,** where a witness had testified that the defendant had certain tattoo marks on his person, the defendant was compelled by the court to exhibit these marks to the inspection of the

* Beck's *Medical Jurisprudence*, vol. i., p. 661.
† Ram on Facts (3d Am. ed.), p. 412.
‡ *Ibid.*, p. 432.
§ Taylor's *Medical Jurisprudence*, p. 347; Ram on Facts (3d Am. ed.), p. 420.
‖ Taylor's *Medical Jurisprudence*, p. 361.
¶ *People vs. Wilson*, 3 Parker's Crim. Rep. 199.
** *People vs. Ah Chuey*, 14 Nev. 89; s. c. 33 Am. R. 530.

jury. Not a little diversity of opinion,* however, has existed with reference to the propriety of such procedure, and the weight of authority would seem to sustain the view that to compel the prisoner to exhibit the marks upon his body is to compel him to give evidence against himself, and is therefore a violation of his constitutional immunity. A distinction has, however, been drawn between those cases, on the one hand, where the prisoner has been required to expose to view marks not commonly visible, and those cases, on the other hand, where he has sought to conceal his form or features by the use of a mask or a veil or some other disguise.† The constitutional immunity extends to cases of the one class, but it is doubtful whether the immunity is broad enough to cover cases of the other.

Probably of all marks upon the body, marks of tattooing, by reason of their frequent presence, have most often played a part in judicial inquiries as to personal identity; and the common introduction of such evidence has raised extended discussion as to whether these symbols may not, in the course of years, spontaneously disappear. The conclusion arrived at by Dr. Taylor‡ after a careful résumé of the recorded cases—a conclusion which seems in harmony with the prevailing current of authority—is "that tattoo marks once properly made in the cutis are practically indelible; but that when the operation is imperfectly performed, the marks may, in the course of many years, become lighter and disappear. . . . The only methods by which such marks admit of removal are by excision of the cutis or the application of actual cautery or escharotics to destroy the skin. In such cases, cicatrices remain, which under a proper examination may lead to detection."

A curious instance, which will serve as an illustration of the questions that arise in this connection, is cited by Dr. Taylor§ from the records of the courts of France. "A man named Aubert was charged with having committed a robbery in 1843. His defense was that he was at that date confined in a certain prison under the assumed name of Solignon. On searching the prison register it was found that a man named Solignon was there confined at the date assigned, and the description of the prisoner showed that he was tattooed on both arms—on the left there were two hearts, a dog, and other emblems; on the right, a man, a woman, a dog, and two hearts. On examining the prisoner Aubert no marks of tattooing were seen upon his arms, although he affirmed that he had been tattooed by a friend in 1840 and again in 1846 with a blue vegetable ink, but that he had some months ago removed the marks by a chemical process. He also described the marks; those on the right arm represented the bust of a woman and the letters J. S., and on the left arm a tomb, with foliage, etc. In 1846 a hunting scene had been added, but this was the faintest of all. By close examination of the skin with a lens

* See 22 Alb. Law Jour. 144; *People* vs. *McCoy*, 45 How. Pr. 216; *State* vs. *Garrett*, 71 N. C. 85; s. c. 17 Am. R. 1; *Blackwell* vs. *State*, 67 Ga. 76; s. c. 44 Am. R. 717; *Stokes* vs. *State*, 5 Baxt. 619; s. c. 30 Am. R. 595; *Boyd* vs. *United States*, 116 U. S. 616; cf. *Counselman* vs. *Hitchcock*, 142 U. S. 547. Contra, *Walker* vs. *State*, 7 Tex. Ct. of App. 245; s. c. 32 Am. R. 595; and see *State* vs. *Graham*, 74 N. C. 646.

† So it has been held permissible to summon a defendant to the bar for the purpose of identification. *People* vs. *Mount*, 1 Wheeler's Crim. Cases, 411.

‡ Taylor's *Medical Jurisprudence*, p. 355. See also Wharton and Stillé's *Medical Jurisprudence*, vol. ii., p. 261.

§ Taylor's *Medical Jurisprudence*, p. 356.

in a strong light, M. Tardieu was able to detect faint white marks like cicatrices, representing the outline of a tomb with two hearts, and the marks indicative of two letters were also detected on the skin of the other arm by the same means. By these observations, the non-identity of the accused Aubert with the former prisoner Solignon was clearly proved. Both were tattooed, but the tattoo designs were quite different, and under less skillful hands than those of M. Tardieu, Aubert might have escaped the punishment which he merited."

A similar inquiry has been raised, and analogous cases have arisen, with reference to the possible effacement of cicatrices or scars; but the physicians are apparently agreed * that "all scars resulting from wounds and from cutaneous diseases which involve any loss of substance are indelible; the only exception that can be made being in regard to trifling punctured wounds, where but little violence has been done to the skin."

(2) *Teeth.*—Some very striking instances of the recognition of persons by peculiarities of teeth are reported in the books. The trial of Professor Webster for the murder of Dr. Parkman—one of the classics of the criminal law—is perhaps the most notable illustration of the employment of this form of proof.† The body had been consumed in a furnace; but the artificial teeth, being composed of an infusible material, remained substantially intact. It was shown by the dentist, Dr. Keep, that a peculiar set of teeth had been constructed by him for the murdered man; and the production of the trial-plate and the mold of the jaw, and the correspondence of the teeth found in the furnace with the peculiar formation of the plate and mold, pointed with almost convincing force to the identity of the victim. So, in a case which came before the courts of New York, the body of a man was found six months after a supposed murder, and the inquiry turned upon the question of the man's identity. A dentist who testified that he had extracted some teeth for the person believed to have been murdered, proved also that on the teeth remaining there were certain peculiar marks. Evidence was offered that the same teeth were absent from the jaw of the body that had been found; and similar marks in the other teeth were shown to exist.‡

(3) *Hair.*—The same case affords an illustration of the possibility of identifying a body by peculiarities in the color of the hair or beard. It has been held, however, that an expert witness who has made a study of human hair, on being shown hair from the head of the victim of a murder and hair found with blood on it upon a wheelbarrow belonging to the accused, may not be permitted to give his opinion, founded only on the ordinary appearance of the hair, that the two were from the same head.§ That is a conclusion to be drawn only by the jury from the points of resemblance or diversity which the evidence may disclose.

(4) *Size and Stature.*—In Lindsay's case, the measurement of the body was one of the tests adopted for the purpose of identifying the victim; and in the case of *The People* vs. *Wilson*, the correspondence of the height of the body which had been washed ashore with that of the man believed to have been murdered, coupled with the fact of an unusual length of

* Wharton and Stillé's *Medical Jurisprudence*, vol. ii., § 301; Taylor's *Medical Jurisprudence*, p. 348.

† *Com.* vs. *Webster*, 5 Cush. 295.

‡ *Lindsay* vs. *The People*, 63 N. Y. 143; and see *State* vs. *Vincent*, 24 Iowa, 570.

§ *Knoll* vs. *The State*, 55 Wis. 249; s. c. 42 Am. R. 704.

face, facilitated the solution of the problem of identity. So in the trial of Arnaud before the parliament of Toulouse, a shoemaker testified "that Guerre's foot reached to the twelfth size, whereas the foot of the accused reached no further than the ninth."

It is remarked by Mr. Burrill in his treatise on circumstantial evidence* that size is the circumstance "which ordinarily makes the first impression on the sense of vision when directed toward a particular person; and where it exists in excess or the reverse, as where the person is unusually large or unusually small, much below or much above the common height, it always arrests the attention and impresses the memory. The impression it makes is an instantaneous one, and may be received under circumstances admitting *any* exercise of the faculty perceiving it. Hence, it may be observed under circumstances of imperfect light or hurried motion, which would not admit of the observation of minuter peculiarities. If there be light enough to see an individual with any distinctness at all, the outline of his person, which suffices to give an idea of his size or stature, must be visible. It is, moreover, a circumstance which cannot, ordinarily, be disguised by artificial means, like other personal peculiarities." †

(5) *Voice.*—Singularities of voice have sometimes served as an important aid in judicial inquiries touching the identity of men. In Hoag's case, a peculiar shrill tone and the presence of a slight lisp were among the marks of correspondence of which evidence was given. In Harrison's case,‡ which is cited by Wharton and Stillé in their book on medical jurisprudence, "a witness testified that on the night when the deceased was found strangled in a hackney-coach in the street, she saw a coach stop at a place named, and heard a person in the coach tell the coachman to go to a certain house, and when he did not go fast enough she heard the passenger swear at him for going so slow. Afterward she saw the coachman return with the deceased, who entered the coach. The witness upon hearing the voice of the prisoner declared that it was the same she heard swear at the coachman on the night in question, and in this way led to an entire identification." §

The principle that evidence of voice is a legitimate means for the solution of questions of identity finds, I suppose, a logical, if somewhat startling, extension in the rule announced by a decision in New York that the identity of a dog may be shown by the peculiarity of its bark.||

(6) *Dress.*—In connection with the subject of the identification of persons by means of bodily peculiarities, mention may appropriately be made of cases where a man's dress or other articles connected with his person have furnished a decisive clew to his identity. Cases of this character, as might reasonably be expected, are extremely numerous. In Howe's case,¶ for example, a fawn-skin waistcoat was particularly noticed as an article of the prisoner's dress; and "the *absence* of an

* Burrill, *Circumstantial Evidence*, p. 638.

† For other illustrations of identification by means of stature, see *Barbot's Case*, 18 State Trials, 1267; *Rex* vs. *Brook*, 31 id. 1137; *State* vs. *Avery*, Burrill, Circ. Ev., p. 621. So a man's carriage—for example, a habit of stooping or of carrying the head on one side—may serve to identify him. *Regina* vs. *Brush*, Burrill, Circ. Ev., p. 638.

‡ 12 State Trials, 850, 860.

§ See also *Com.* vs. *Scott*, 123 Mass. 222.

|| *Wilbur* vs. *Hubbard*, 35 Barb. 303.

¶ Wills, *Circumstantial Evidence*, p. 234; Burrill, *Circumstantial Evidence*, p. 639.

article of apparel usually worn out-of-doors, such as a hat, constitutes an observable circumstance by which a person may be identified." * It has frequently happened that in cases of death by violence, where the body of the victim was no longer recognizable, the discovery of his clothing, hat, or papers has been the sole agency through which the question of his identity could be solved.† In a recent case in this State, the body of the victim, supposed to be one Bernard, was in a decomposed and mutilated condition. A satchel near the body containing an almanac on which the name "Bernard" was written, keys on the body which fitted the lock of the satchel, shoes and other articles of clothing recognized as belonging to the murdered man, were the only tokens by which identity could be revealed.‡

Not only the dress of the victim, but the peculiar nature of any other object in his possession, may thus become important. Cases, for example, may be cited where evidence as to the color of a man's horse has opened the door to the solution of problems of this kind.§

Akin to these cases in principle are cases where articles belonging to the prisoner have been found near the scene of the murder;‖ or where articles known to have belonged to a person believed to have been murdered are found in the possession of the prisoner himself.¶

Peculiarities of dress, like peculiarities of stature, are wont to arrest the attention of the observer and to stamp themselves sharply upon the memory. They enter largely into our notion of a man's general appearance; and more often perhaps than any strictly physical qualities have they played a part in the solution of questions of this character.

(c) **Mental Traits.**—It has frequently happened, however, that with the most striking similarity of bodily form and features, the mental attributes of two men have been proved to be so radically divergent as to exclude the hypothesis of their identity. Evidence as to the mental powers and attainments of persons whose identity is at issue has been frequently received, and often with the most telling force.

Thus, in Guerre's case, Arnaud's ignorance of fencing—an art in which Guerre was proved to have been expert—was noted as repelling the inference of the identity of the claimant with the absent man. In Hause's case, a circumstance that had led to the acknowledgment of the defendant as the missing son was his familiarity with certain local tales which the son was known to have learned. But the most conspicuous instance of the potency of evidence of this kind may be found in the Tichborne case, to which reference has been so often made. The claimant, as we have seen, had been acknowledged by Sir Roger's mother as her son; a host of witnesses had corroborated the mother in declaring that he was the true heir to the estate; and yet in the face of all this proof, in the face of the most striking similarities of feature and of form,

* Burrill, *Circumstantial Evidence*, 640. See also *Barbot's Case*, 18 State Trials, 1229; Wills, *Circumstantial Evidence*, 96; *Com.* vs. *Reardon*, 4 Gray, 420.

† *Taylor* vs. *State*, 35 Tex. 97; *State* vs. *Williams*, 7 Jones, 446; *Regina* vs. *Hopkins*, 8 C. & P. 591; *People* vs. *Beckwith*, 108 N. Y. 67, 73.

‡ *People* vs. *Palmer*, 109 N. Y. 110.

§ *Williams* vs. *State*, 24 Tex. App. 17.

‖ *People* vs. *Hamilton*, 137 N. Y. 531; *State* vs. *Rainsburger*, 74 Ia. 196; *Caldwell* vs. *State*, 14 S. W. Rep. 122; Burrill, *Circumstantial Evidence*, p. 642.

¶ *Taylor* vs. *State*, 35 Tex. 97; *State* vs. *Wagner*, 61 Me. 178; Burrill, *Circumstantial Evidence*, p. 642.

the disparity in the intellectual acquirements of the two men stamped the claim as a scheme of perjury and fraud. The claimant's "ignorance of the mother-tongue of the real Sir Roger; his ignorance of the town in which the first sixteen years of the life of Sir Roger had been passed; his ignorance of the rudiments of knowledge which Sir Roger was shown to have possessed;" his want of those instinctive tendencies of mind which a man of Sir Roger's birth and breeding could never, it was felt, have lost—all this combined to overthrow the formidable fabric of proof that had been reared in his behalf. It could not be that in twelve years a man who was still, by concession, a keen, an intelligent, an able man, could have lost every distinctive trait of mind that had marked him off from others in the past.

And yet the case raises an interesting doubt. Is it in fact true that the things of the mind are to such a degree more constant and immutable than those of the body? Hundreds of years ago, as we have seen, Zacchias did not hesitate to answer to his inquirers that toil and hardship, exposure and suffering, the thousand incidents of a busy and active life, might change the form of the man of mature years beyond recognition by the friends of the youth. Can the same answer be made of the things of the mind? Do they survive and defy all the conflicts and storms, all the errors and weaknesses, of a tumultuous or a dissolute life? We cannot answer with assurance that they do; and yet we feel that, more perhaps than any trait of feature or of form, the possessions of the mind are indeed a possession to us forever. The mind, of course, may be blotted out; its powers may be atrophied or dulled; but while general intelligence apparently survives unimpaired, we can hardly conceive but that some vestiges of its past attainments, a scrap or tatter of its bygone powers, would outlive the wreck and ruin of the past. Some faint and feeble echo, some elusive, mocking memory of what was once its own, would haunt it with a sense of latent force, and stir it sometimes with resurgent powers. There have been cases, doubtless, where for long days and nights, as George Eliot has said of her own Baldassarre, "memory has been little more than the consciousness of something gone"; there have been cases where by some passing emotion the vibrations of that memory have been stirred, and the old scenes, the old knowledge, the old associations have struggled forth, and waked the mind at last. But these were cases of mental decay or of mental stupor which affected the mind in its entirety. They do not make it the easier to believe that, along with present ability and mental force, complete loss of past acquirements should coexist. We can conceive, in short, of the destruction of the mind; we can conceive of the impairment of its faculties; but we can hardly conceive that with the mind still existent, with general intelligence still surviving, with no trace of idiocy or senility at hand, the mind should be substantially a different mind from that which once it was. We can conceive of it as annihilated, we can conceive of it as impaired; but with difficulty can we conceive of it as transformed.

Yet the inference of the identity of the Tichborne claimant with the missing heir to the estate was not only overborne by the diversity of their mental traits; it was overborne by the very theory and basis of the claim. Why Sir Roger Tichborne should have led this wandering life, why he should have left his home to act as a horse-breaker, a stock-driver, and ultimately a butcher, why he should have abandoned the splendors

The possession, for example, of the fruits of theft, at a period not too remote from the date of its commission, is a circumstance that would naturally have followed the offense, and so their possession is often cogent evidence of the identity of the accused. The presence of the prisoner at the scene of the crime, the purchase by him of weapons with which the crime might be committed, the flight of the accused, or his demeanor upon the stand—all these are relevant as circumstances more or less significant of the identity of the perpetrator of the wrong. And these circumstances need not, of course, be proved by direct evidence; they may be proved indirectly as well. The presence of a prisoner at the scene of a murder has repeatedly been evidenced by correspondence between the size of his boots and of footprints discovered upon the ground.* And all these elements of proof, motive, preparation, subsequent incriminating acts or words—inconclusive frequently alone—may be so combined as collectively to fix the identity of the criminal to the exclusion of every other reasonable hypothesis.†

The propriety, however, of leaving to circumstantial proof the identification of a murdered body has not passed entirely unchallenged. It was a rule of the common law that the *corpus delicti* in cases of murder had two components, death as a result, and the criminal agency of another as the means; and it was only where there was direct proof of one element that the other could be established by circumstantial evidence.‡ That rule, however, was satisfied when the death of *some one* was directly proved; the identity of the victim might be indirectly shown. A case § came before the courts of New York not many years ago, in which it was claimed that the provisions of the Penal Code ‖ had changed the rule of the common law, and required direct evidence, not of the fact of death alone, but of the two facts of death and of identity. The body of the victim had become so decomposed that personal recognition was impossible; and to sustain the prisoner's claim would have been to grant him complete immunity from punishment for his crime. But the court construed the provisions of the statute in the light of the history of the rule, and held that the law had not "placed a premium upon the brutal courage which can mangle and burn the lifeless body."

A wide range, it will be found, has been given by the decisions to the instrumentalities by which identity may be shown. The complex nature of the problem has led the courts to avail themselves of every agency by which a sound conclusion might conceivably be reached. They have permitted, with substantial unanimity, the introduction of properly authenticated photographs ¶ as evidence of general appearance or of special physical traits; and important aid has often thus been lent to the deter-

* See, for example, *Clawverius* vs. *Com.*, 81 Va. 787; *Sutton* vs. *Com.*, 7 S. E. 323; *Caldwell* vs. *State*, 14 S. W. 122; *People* vs. *McCurdy*, 68 Cal. 576; *People* vs. *Myers*, 70 Cal. 582; *State* vs. *Read*, 89 Mo. 168; *People* vs. *McCallam*, 3 N. Y. Crim. Rep. 189.

† See, for example, *People* vs. *Johnson*, 140 N. Y. 350.

‡ *Ruloff* vs. *The People*, 18 N. Y. 179.

§ *People* vs. *Palmer*, 109 N. Y. 110.

‖ Section 181 of the Penal Code prohibits a conviction "unless the death of the person alleged to have been killed, and the fact of the killing by the defendant as alleged, are each established as independent facts, the former by direct proof and the latter beyond a reasonable doubt."

¶ *Marion* vs. *The State*, 20 Neb. 233; s. c. 29 N. W. 211; *People* vs. *Cowley*, 83 N. Y. 464; *People* vs. *Buddensieck*, 103 N. Y. 487; *People* vs. *Fish*, 125 N. Y. 136.

mination of the issues in dispute. Images of a rude kind have served, indeed, since early times as a means for identifying bodies; and Charles I. of England was recognized,* it is said, by his resemblance to the head upon coins of the realm which had been issued in his reign.

Nice problems of evidence in connection with questions of identity have frequently arisen in the course of bastardy proceedings, and there has been some diversity of opinion † as to whether, in passing upon the identity of the parent, where the child and its putative father are present in the court, the jury may take into account the resemblance of the one to the other. The mere opinion of a witness, however, as to the existence of such a resemblance, has, it would seem, been generally excluded,‡ and the courts have required that the resemblance should be shown by the comparison of the two persons in open court before the eyes of the jurors.§

No very definite statement can be found, and none in the nature of things could well be given, as to the degree or cogency of proof that is required before the inference of identity will be drawn. The mere fact that a witness hesitates in the identification of a criminal,‖ or that his evidence is in some respects conflicting,¶ has been held insufficient cause for the withdrawal from the jury of the issue of identity; but, on the other hand, if it plainly appear that the testimony of the complainant is little more than a conjecture or suspicion, the courts have not hesitated to declare that a conviction is unwarranted.**

The tendency of a study of the cases of disputed identity is to break down the supposed distinction between direct and circumstantial proof, and to lead to the conviction that, at least in cases of this character, the latter form is perhaps the safer of the two. From the standpoint of psychology, the distinction is of doubtful validity at best. So little of our knowledge is directly given us by our senses, so little of it but is the product of association and comparison working upon the raw material which the senses supply, so much that seems to us immediate and direct is, in reality, mediate and indirect, that from a philosophical standpoint almost all evidence is the evidence of a fact, not directly, but indirectly perceived. I find a notable judicial recognition of this truth in Judge Gray's opinion in the recent case of The People against Harris.†† "All evidence," he says, "is in a strict sense more or less circumstantial; whether consisting in facts which permit the inference of guilt, or whether given by eye-witnesses of the occurrence; for the testimony of eye-witnesses is, of course, based upon circumstances more or less distinctly and directly observed."

Such a notion as this of the inherent parity of seemingly divergent forms of proof was impossible for the jurists of an earlier day. That

* Mason, J., in *Ruloff* vs. *The People*, 3 Parker's Crim. Rep. 401.

† See, for example, 50 N. J. Law, 490; 67 N. C. 89; contra, 81 Me. 348.

‡ *Young* vs. *Makepeace*, 103 Mass. 50.

§ On the rule that identity of name is *prima facie* evidence of identity of person, see *Stebbins* vs. *Duncan*, 108 U. S. 32; *Spotten* vs. *Keeler*, 22 Abb. N. C. 105, note. But this presumption is not of universal application. *Hoyt* vs. *Newbold*, 45 N. J. Law, 219; s. c. 46 Am. R. 757.

‖ *People* vs. *Foley*, 27 W. Dig. 217.

¶ *People* vs. *Bracco*, 69 Hun, 206.

** *People* vs. *Smith*, 7 N. Y. Crim. Rep. 425.

†† *People* vs. *Harris*, 136 N. Y. 423.

it should have found, as I believe it has, a conscious lodgment in the law at all, is proof of the reaction upon legal science of the other departments of man's knowledge and advancement. The truth is, as every student of psychology knows, that very little of what we seem to see is actually given us by sight alone. It has been pointed out, I believe by Mr. Mill, that the act of mind which is indicated by the words "I see my brother" is not merely a perception, but an inference. The cases which legal medicine has collected show that it is not only an inference, but an inference in certain instances of the most uncertain and dubious kind. When the Tichborne claimant, in the words of the lord-chief-justice, "stood as it were between two persons, between Arthur Orton on the one hand and Roger Tichborne on the other, and while he declared that he was Roger Tichborne, a host of witnesses declared that he was Arthur Orton," the truth that almost all evidence is a conclusion, that the difference between the proof we call circumstantial and the proof we call direct is one not so much of kind as of degree,—that truth received an object illustration which we might hardly expect to meet with in the musty records of the law.

We commonly permit a witness to testify directly: "This is the man that I have seen before." We think of this testimony not as an inference or a conclusion; we think of it as a statement of a fact. The psychology which tells us we are in error, we brush aside as speculative and unpractical in its views; and doubtless for the ordinary purposes of life we are entirely in the right. None the less, however, is a conclusion really drawn; a conclusion whose data are the acts, the impressions, the memories of a lifetime; a conclusion whose premises are so manifold and so complex that they are lost and scattered and merged before the inference has, almost unconsciously, been reached. And the law is quite consistent with itself, quite consistent with elementary rules of proof, when it permits the witness, omitting the process which generated the belief, to testify to the resultant fact. That infraction of the cardinal rule that testimony as to opinions may not in general be received, is one that finds manifold illustrations in the books. The law recognizes the fact that there are certain unconscious inferences where the average mind can only testify to the inference itself; that there are certain complex processes where the individual links in the chain of thought, if presented one by one, would lose their meaning and their force; that there are certain opinions which, as the courts have put it, are "but abbreviations of the facts."* But every now and then a case arises which puts the problem in its true light; and the knowledge that seemed to us immediate is seen to be the result of a long process of reasoning—an elaborate train of thought.† We are surprised and awakened at times into a consciousness that there is a practical side to this analysis of the phenomena of the mind—that as a working hypothesis we may treat it as superfluous, but that it discloses a deep truth which may not permanently be ignored.

* *Sloan* vs. *R. R.*, 45 N. Y. 125; *People* vs. *Wright*, 136 N. Y. 625; *Knoll* vs. *State*, 55 Wis. 249; *Udderzook* vs. *Com.*, 76 Pa. St. 340; *State* vs. *Dickson*, 78 Mo. 438; *People* vs. *Rolfe*, 61 Cal. 540; *De Witt* vs. *Barly*, 17 N. Y. 340.

† So, too, the identity of physical objects, it may be noted, is generally to be determined by the tests of the popular understanding; yet "even lawyers are occasionally called upon to consider more minutely in what the identity of a thing consists." Holland's *Elements of Jurisprudence*, p. 88; and see *Silsbury* vs. *McCoon*, 3 N. Y. 379.

There is a case illustrative of this which is reported in the early decisions of the criminal courts of New York.* A dead body with marks of violence upon it had been washed ashore. It was alleged that the body was the body of Captain Palmer, but personal, immediate recognition had long become impossible. "The height of the deceased was shown, an unusual length of face, and a widening of the end of the little finger to which in a general way the body corresponded. But a more important fact was that the captain had imprinted his name upon his arm and leg; and on the same portions of the body found the skin had been cut away, except that on the leg the letter P remained visible. A brother-in-law of the deceased, who had seen the body, was asked the direct question whose body it was; but the court would not permit an answer, saying that the question was not the ordinary one of personal identity, since the body had been submerged for five months, but was one of an inference from resemblances, which the jury and not the witnesses must draw."

In all this, as I have already said, the law is thoroughly consistent. Systems of law must deal with the acts of the mind as the common apprehension deals with them. The subtleties of psychological analysis cannot be permitted to disturb the current of forensic proof. Whether or not the so-called philosophy of common sense be a sound system of metaphysics, it is the only metaphysics on which a body of law can be built. The rudest and the most developed systems alike are constrained to adopt as their final or at least prevailing tests the hasty and superficial notions of the popular intelligence. Primitive law never attempts in the slightest degree to penetrate back of the common understanding of things and into their essential nature. It sees only the outward forms of transactions; it is blind to their inherent substance. The spoken word is binding, though it was spoken under the coercion of fraud or of mistake.† We of to-day have shaken ourselves free from that primitive subordination to the external shows of things; we have striven to some extent to substitute the ideal for the popular conceptions; but the tendency has its limits that are well defined; they are defined both by the inherent purpose of law itself and by the possibilities of human proof. The law is concerned with "objective conformity to a rule"; and if, as it would seem to be, the history of legal progress has been the history of a development from form to substance, from that which is accidental to that which is essential, from a sort of legal anthropomorphism to a sort of legal spiritualism, it is still true that the law was made for a work-a-day world; that it must often rest satisfied with external standards, and govern itself by rules which it knows are but provisionally true.

I think, therefore, that in its solution of problems of identity, and in its answer to the questions of evidence involved, the common law has shown a vigorous and healthy spirit. It seems to me to have pursued the just mean between the dangerous extremes of metaphysical refinement upon the one hand and superficial formalism upon the other. And that healthy and vigorous spirit which the law has manifested here, it has preserved in its treatment of other and analogous questions that often remain to be solved after the preliminary question of identity has been settled. The bodies of persons who have perished in a common calamity are

* *People* vs. *Wilson*, 3 Parker's Crim. Rep. 199; and see statement of Finch, J., in *People* vs. *Palmer*, 109 N. Y. 110.

† Maine, *Ancient Law*, pp. 303, 304.

found; the resources of science are taxed in the effort to determine their identity; and that question being answered, the inquiry will still remain, Which of the two persons was the first to die; which of them was the survivor?

Survivorship.—It is the tendency of all systems of law as they develop to narrow the field of presumptions. Like the fictions which with early law supply the place of legislation, presumptions find their widest field in the infancy of legal systems. The refusal of our law to adopt a formal or artificial doctrine as to the survivorship of those who have died in a common calamity is quite in harmony with the course and history of the development of its rules of proof.

Yet it is a somewhat noteworthy fact that almost every system of law has solved problems of this character by certain fixed and formal tests. We are referred to the Mahometan law of India, and are told that where relatives perished together it was presumed that the same moment marked the death of all.* We turn to the Roman law,† and we find that it, too, had its fixed and *à priori* rules. Where husband and wife were lost, the former was adjudged the survivor. Where father and son had died together, the son, if below the age of puberty, was deemed the first to have succumbed; if above that age, he was deemed to have been the survivor. In the same spirit, the Code Napoleon ‡ declares that if those who perished together were under fifteen years, the oldest should be presumed the survivor; if they were all above sixty years, the youngest should be presumed the survivor; if some were under fifteen, and others above sixty, the former should be adjudged the survivors; if those who had perished together had completed the age of fifteen years, and were under sixty, the male should be presumed the survivor, where ages were equal, or the difference did not exceed a year; if they were of the same sex, that presumption should be admitted which would open the succession in the order of nature; thus, the younger should be considered to have survived the older. The same rules, it is said, were in force in the territory of Orleans at the time of its cession to the United States, and have since been incorporated into the code of Louisiana.§

The principles of the Roman law regulated for many centuries the practice and speculations of European jurists, and statutory enactments of more recent date have served in some instances to perpetuate these or similar presumptions. It is not unnatural, therefore, that when the question first presented itself to an English court, the common law, awed, it may be, by the imperious authority of Roman jurisprudence, should have faltered for an appropriate reply. The question arose in 1766, after the loss by shipwreck of General Stanwix and his daughter. On the one hand the nephew of General Stanwix, on the other hand the maternal uncle of the daughter, laid claim to the personal estate. It was urged that the general, a soldier and a man of courage, might reasonably be supposed to have struggled long and earnestly against the fury of the waves. It was urged on the other hand that the general was old and feeble, and that the chance of survival was rather with the daughter, who

* Greenleaf, *Evidence*, vol. i., § 29; *Cowman* vs. *Rodgers*, 73 Md. 403.

† Dig. Lib. 34, tit. 5; Greenleaf, *Evidence*, vol. i., § 29.

‡ Code Civil, §§ 720–722; *Coye* vs. *Leach*, 8 Met. 371; Greenleaf, *Evidence*, vol. i., § 29; Beck's *Medical Jurisprudence*, vol. i., p. 626.

§ Civil Code of Louisiana, arts. 930–933; Greenleaf, *Evidence*, vol. i., § 29.

retained her youth and health. The learned court was so impressed with the force of the arguments upon both sides that it confessed its inability to arrive at any conclusion, and the case is authority for nothing, except for the complexity of the problem.*

Yet the courts seem at an early day to have felt that the question, if it was to be solved at all, should be solved by evidence, and not by *à priori* rules. Even in the familiar case which is cited by Blackstone,† where a father and son were hanged at the same time, and the son, being observed to struggle longest, was decreed to be the survivor, the law, if it drew its inference from somewhat inconclusive evidence, was still faithful to its requirement of proof. And though no very satisfactory discussion of the true principles applicable to cases of death by a common disaster can be found in the early English reports, still the trend of judicial dicta and decision ‡ was entirely in the direction of the rule that has since become firmly established both in that country and in our own.

In the United States the question first presented itself in connection with the loss of the steamer "Pulaski," in June, 1838. Among the victims of that disaster were a man named Ball, his wife, and his adopted daughter. By the terms of his will Ball bequeathed to his wife, in the event that she survived him, certain portions of his estate; and her representatives brought suit in the courts of South Carolina, and sought to establish her rights as the survivor of her husband. The opinion of the chancellor § treats the question as one that should be determined not by presumptions, but by proof. He discusses in much detail the circumstances of the loss of the ship as narrated by survivors of the calamity; he notes the fact that Mrs. Ball was the last to be seen alive; he notes the fact that her husband may *possibly* have escaped the explosion which shattered the boat, but that she, as the testimony showed, had *certainly* escaped it; he notes the fact that her husband failed to respond in answer to her cries, which were heard above the din of the disaster; and grouping these and other circumstances together, he reaches the conclusion that the husband was the first to die. "The right on the part of Mrs. Ball," says the chancellor, "is derivative, and the burden is on the plaintiffs to prove that she was the survivor; but although bound to prove it, it does not follow that they are to prove it to demonstration; we must take the best evidence the case affords." Unwilling to rest on the fact that Mrs. Ball was the last person seen, he prefers "to put the case upon the ground of probability arising from the evidence upon a belief engendered by a combination of circumstances, and upon the superiority of positive proof over conjecture or even probability."

Subsequent decisions ‖ have perhaps cast a doubt upon the sufficiency of the evidence from which the conclusion of survivorship was drawn by the chancellor; but the theory and basis of the judgment, it would seem, have never been impugned.

A few years later, in 1844, the courts of Massachusetts were asked in

* *The King* vs. *Dr. Hay*, 1 W. Bl. 640.

† Bl. Comm.

‡ *Wright* vs. *Sarmuda*, 2 Phill. 266; *Selwyn's Case*, 3 Hagg. Eccl. R. 748; *Mason* vs. *Mason*, 1 Meriv. 308.

§ *Pell* vs. *Ball*, 1 Cheve's Ch. Cases.

‖ *Russell* vs. *Hallett*, 23 Kan. 276; In re *Ridgway*, 4 Redf. 226; *Wing* vs. *Angrave*, 8 H. of L. Cases, 183.

a case resulting from the same calamity to apply the presumption that a daughter of thirty-three had survived her father, a man of seventy years. The court declared* that no legal presumption of survivorship existed, and that in the absence of evidence as to the time and manner of the death of the victims the law could frame no judgment as to the relative duration of their lives. The rules of the civil law, it was said, "are clearly arbitrary rules, as in the nature of things a week or a day less than the respective ages named would not usually, in any degree, affect the ability of the party to sustain and prolong life in case of exposure by shipwreck. Such rules, being thus arbitrary in their character, to some extent, would seem to require a legislative act for cases of this character and description. But without such legislation we do not feel authorized to adopt any fixed period of age as decisive of the question of survivorship of those who perish in a common disaster, and where no facts or circumstances are known that would aid in deciding the point of survivorship. To a certain extent we might well go, in applying the principle as to disparity of age. Thus it would be proper and reasonable to hold that one in middle age and in the full vigor of life would ordinarily survive a mere infant, or child of very tender years; and the same would be alike true as to such person and the man well stricken in years."

These were the pioneer cases upon this troublesome topic of the law. If their discussion of the question was somewhat fragmentary and faltering, they displayed at least a sound intuition as to the appropriate legal rule. Subsequent decisions, however, have considered the subject with a wealth of argument that has withdrawn the topic from the realm of the debatable problems of the law.

In 1854, in the case of *Underwood* vs. *Wing*,† the courts of England were confronted again with the necessity of declaring the true doctrine that was applicable to such a case. "The question of survivorship," they declared, "is the subject of evidence to be produced before the tribunal which is to decide upon it, and which is to determine it as it determines any other fact. If there be satisfactory evidence to show that the one survived the other, the tribunal ought so to decide; and if there be no evidence, the case is the same as a great variety of other cases, more frequent formerly than at present, where no evidence exists, and consequently no judgment can be formed. We have no doubt that the scientific gentlemen who were examined were perfectly sincere in their opinions, but it is obvious that their opinions were given having reference to the case of two persons quietly submerged in water and remaining there until drowned, or to the case of two persons, one being a swimmer and the other not, and both thrown suddenly into the water unincumbered, and acting on certain instinct. The present case is that of two persons clasped together, two boys clinging to one of them, and standing pretty high out of the water on the ship's side, swept off together by an overwhelming wave into a raging sea, and one or other, or both of them, may have been stunned by the violence of the blow from a wave, or they may have struck against a timber of the ship, and may have, in fact, been dead before he or she reached the water at all. How is it possible, under such circumstances, for any tribunal, sitting judicially, to say which of

* *Coye* vs. *Leach*, 8 Metc. 37; s. c. 41 Am. Dec. 518.

† *Underwood* vs. *Wing*, 4 DeG., McN., & G. 633; s. c. 31 Eng. Law & Eq. 293.

these two individuals died first? We may guess, or imagine, or fancy, but the law of England requires evidence."

The opinion of Lord-Chancellor Cranworth, in the same case, is substantially to the same effect. "I give the medical gentlemen," he says, "most entire credit for speaking scientifically, and, as we believe, quite accurately. I do not think that they themselves even are very confident. Indeed, it is idle when you are calculating and reasoning *à priori* in this way, as to which of two persons may have breathed a few seconds the longest at the bottom of the sea; for that is all it comes to. To think that one can take that as establishing the fact seems to me to be quite misunderstanding the nature of human testimony. The medical men may be quite right in the observations they have made of persons dying of asphyxia; that there is a small interval, of perhaps half a minute, after sensation has ceased, in which life still continues; and I think they say that that is, as far as their observation goes, uniform in all states of health and in all states of strength. I dare say that may be very learned and probably accurate, as far as science enables us to form such an opinion; but happily the instances of such events cannot have been sufficiently numerous to have enabled anybody to have formed at all an accurate and certain conclusion on such a difficult subject; and I confess that I rose from the perusal of their evidence utterly unconvinced that those gentlemen can tell us which of them died first if they had both been taken and quietly submerged to the bottom of the sea. But when you add to that that they are all violently thrown by one blast from the side of the ship, and may have fallen against some spars (from what we know, that may have been so); and then in the whirlpool and confusion of the moment to pretend that you can come to any conclusion on which you can act, that these medical gentlemen are right in supposing the wife did die a few seconds before the husband, seems to me to be confusing and confounding the province of human testimony."

The doctrine of *Underwood* vs. *Wing* received new confirmation, and its limits at the same time were more sharply defined, by a decision of the House of Lords, which was rendered in 1860.*

"When two persons," said Lord Chelmsford, "are swept away by a calamity like that which happened in this case, it is possible that there may be evidence to prove distinctly which was the survivor; as where one of them has been seen struggling with the waves after the other has sunk, and never again appeared above the surface, or as in this very case, where there can be no doubt that there is evidence to establish satisfactorily that Catherine, the eldest daughter, survived her parents for some short time, though she afterward perished in the same shipwreck. But where two persons are at one and the same instant washed into the sea and disappear together, and are never seen any more, it is not possible for any tribunal, called upon judicially to determine the question of survivorship, to form any judgment upon the subject which can be founded upon anything but mere conjecture derived from the age, sex, constitution, or strength of body or mind of each individual; and as our law has not established any rules of presumption for these rare and extraordinary occasions, the uncertainty in which they are involved leaves no greater weight on one side or the other to incline the balance of evidence either way."

* *Wing* vs. *Angrave*, 8 H. of L. Cases, 213.

The adjudications of the English courts upon this topic have met with general approval in the courts of the United States; and the decisions in the two countries are in substantial conformity. In New York, in Florida, in Kansas, in Maryland, in Colorado, and in Maine * the courts have declared that there is no presumption of survivorship, and that the rights of representatives must be established through the ordinary agencies of proof. In California, however, the question has been set at rest by statutory enactment; and where two persons perish in the same calamity, such as a wreck, a battle, or a conflagration, and there is no evidence from which it can be shown or inferred which of them was the first to die, if both are over fifteen and under sixty, and the sexes different, it will be presumed that the male survived.† In a case where a husband and his wife were murdered at their home at the same time and the house set on fire, the rule laid down by the statute was applied, and the husband was adjudged the survivor.‡

There were dicta in some of the earlier decisions § which intimate that in these cases of death by a common calamity, the law would presume that all the victims perished at the same time; but later decisions have united in declaring that the presumption of death at the same moment is quite as arbitrary and illogical as the presumption of death according to some fixed and definite principle of succession. "That two human beings," it has been said by Lord Cranworth,‖ "should cease to breathe at the same moment of time is hardly within the range of imagination. I suppose that time, like space, is infinitely divisible; and if we are to speculate on such a subject, one could hardly suppose that the one did not breathe a millionth part of a second longer than the other. Therefore, to adjudicate on a principle that they did actually cease to breathe at the same moment, would, I think, be proceeding on false data. The real ground to proceed on is that it cannot be proved which died first; they both probably died within a few seconds of each other, but which died first it is impossible to say. That being so, what is the result? Why, here is a will made in which in one state of circumstances, namely, that the wife died in the husband's lifetime, the property is given away. It is not proved that that state of circumstances existed, and in no other state of circumstances is it given away. Then it is not given away at all. Therefore, it is to be taken as upon an intestacy, and must be distributed among the next of kin." ¶

The question whether all the victims of the disaster will be presumed to have died together, or whether the law will refuse to draw any presumption whatever, is, after all, a question more of form than of substance. The true principle doubtless is that no presumption at all will be entertained; but "the practical consequence," as has been remarked

* *Newell* vs. *Nicholls*, 75 N. Y. 78; *Smith* vs. *Croom*, 7 Fla. 149; *Russell* vs. *Hallett*, 23 Kan. 276; *Cowman* vs. *Rodgers*, 73 Md. 403; *Kansas &c. R. R.* vs. *Miller*, 2 Col. 442; *Johnson* vs. *Merithew*, 80 Me. 111. The cases in South Carolina and Massachusetts have been already referred to. See also *Fuller* vs. *Linzee*, 135 Mass. 468.

† Cal. Code of Civil Procedure, § 1963, subd. 40.

‡ *Hollister* vs. *Cordero*, 76 Cal. 649.

§ *Moehring* vs. *Mitchell*, 1 Barb. Ch. 265; and see cases cited by Church, C. J., in *Newell* vs. *Nicholls*, 75 N. Y. 78, 90.

‖ *Underwood* vs. *Wing*, 4 DeG., McN. & G. 633; s. c. 31 Eng. Law & Eq. 293.

¶ See also *Newell* vs. *Nicholls*, 75 N. Y. 78.

by Mr. Best,* "is nearly the same, because if it cannot be shown which died first, the fact will be treated by the tribunal as a thing unascertainable, so that for all that appears to the contrary both individuals may have died together."

On the other hand, the law will not presume that there was *a* survivor any more than that there was a particular survivor. In a case,† therefore, where a plaintiff's claim to property might have been sustained equally well by the survival of either of two persons, the court ruled that the claim of ownership had not been adequately established. "It is not impossible," they said, "for two persons to die at the same moment, and when exposed to the same peril under like circumstances, it is not, as a question of probability, very unlikely to happen. At most the difference can only be a few brief seconds. The scene passes at once beyond the vision of human penetration, and it is as unbecoming as it is idle for judicial tribunals to speculate or guess whether during the momentary life-struggle one or the other may not have ceased to gasp first, especially when the transmission of title to property depends upon it; and hence, in the absence of other evidence, the fact is assumed to be unascertainable, and property rights are disposed of as if death occurred at the same time. This is done, not because the fact is proved, or that there is any presumption to that effect, but because there is no evidence and no presumption to the contrary."

But questions of survivorship do not only arise as a consequence of the death of several persons in some common disaster; they arise also where persons have left their homes, and have remained absent from their relatives and friends for an extended period of time. It is a presumption of the law, based upon the known stability of certain human conditions, that a person once proved to have been born is still alive ‡—a presumption which, in general, is only defeated by the lapse of time so great that continuance of life would, in our experience, be palpably impossible.§

But where a man has departed from his home, and for seven years no tidings have been received from him by those who would naturally have heard from him were he alive, it is a doctrine of the law, sanctioned by a long series of decisions, that his death must be presumed.‖ The period of seven years was adopted by the courts in analogy to an early English statute,¶ which exempts from the penalties of bigamy "any person whose husband or wife shall be continually remaining beyond the seas by the space of seven years together, or whose husband or wife shall absent himself or herself, the one from the other, by the space of seven years together, in any parts within the king's dominions, the one of them not knowing the other to be living within that time." Mere absence is not sufficient to satisfy the requirements of the rule;** those who would

* Best on Presumptions, § 144.

† *Newell* vs. *Nicholls*, 75 N. Y. 78.

‡ Greenleaf, *Evidence*, vol. i., § 41; Stephen, *Digest of Law of Evidence*, art. 99; *Eagle's Case*, 3 Abb. Pr. 218; *O'Gara* vs. *Eisenlohr*, 38 N. Y. 296.

§ 92 Am. Dec. 704, note; *Sprigg* vs. *Moale*, 28 Md. 497.

‖ *Eagle's Case*, 3 Abb. Pr. 218; *McCarter* vs. *Camee*, 1 Barb. Ch. 455; *Davie* vs. *Briggs*, 97 U. S. 628; Greenleaf, *Evidence*, vol. i., § 41.

¶ 1 Jac. 1, ch. 11. § 2; and see Penal Code, § 299, subd. 1. Compare the statute relating to persons on whose lives an estate in lands or tenements depends. 19 Car., ii., ch. 6, § 2; and see 1 Rev. Stat. 749, § 6; 5 Barb. 339, 354.

** *Estate of Tobin*, 15 N. Y. St. Rep. 749.

naturally have heard from the absent man must have failed to receive the tidings they might reasonably expect; and even in such cases the presumption of death which arises is not, of course, an irrefragable presumption; it may be overcome either by conflicting presumptions * or by countervailing proof.†

On the other hand, it is not always essential that a period of seven years should elapse before the conclusion of death will be drawn by the law. If, in addition to the fact of a man's absence, it be shown that the circumstances attending his departure were such as to expose him to the chance of peril or disaster, the law, upon proof of these circumstances, may infer that his death occurred before the expiration either of seven years or of any specific period of time.‡ Where, for example, a man attempts suicide and the attempt is frustrated, but the following day he disappears, the law is justified in drawing the conclusion that death occurred about the time of his departure, and the property rights of the survivors will be regulated accordingly.§ And similarly where the vessel in which a man has set sail from his home has long been past due at the port of its destination, and is believed to have foundered in a storm, the fact of death may be inferred before the usual period has expired.‖

A recent case in this State illustrates the application of these doctrines.¶ The missing man had set sail on his yacht for Kingston, Jamaica, and nothing was heard from him except that a vessel resembling the yacht was sighted twenty-nine days after his departure. On March 13, 1888, the day succeeding his departure, a great storm occurred; and the probable situation of the yacht was within the radius, if not within the center, of the hurricane. Pieces of wreckage resembling parts of the vessel were found a few days afterward; and though for six months, by cablegrams and letters, diligent search was made, no tidings of the missing man were received. The court held that his death must be presumed, and that his will, accordingly, should be admitted to probate.

Where, however, the law presumes that a man is dead by reason of his absence, unheard of, for a period of seven years, it will not presume that his death occurred at any specific date within that period of time. As in the case of death by a common disaster, it refuses to indulge in any arbitrary rule; and the precise date of death is left to be established through the ordinary agencies of proof.** Such, at least, is the doctrine

* *Rex* vs. *Twining*, 2 B. & Ad. 336.

† *Stouvenal* vs. *Stevens*, 2 Daly, 319; *Davie* vs. *Briggs*, 97 U. S. 628. So a title to real estate which depends for its validity on the application of this presumption may not be free from reasonable doubt. *Vought* vs. *Williams*, 120 N. Y. 253; and compare *Ferry* vs. *Sampson*, 112 N. Y. 415.

‡ Greenleaf, *Evidence*, vol. i., § 41; Wharton, *Evidence*, § 1283; *Davie* vs. *Briggs*, 97 U. S. 628; *Sheldon* vs. *Ferris*, 45 Barb. 124; *Oppenheim* vs. *Wolf*, 3 Sandf. Ch. 517; *Webster* vs. *Birchmore*, 13 Ves. 362; *Matter of Ackerman*, 2 Redf. 521.

§ In re *Ketcham's Estate*, 5 N. Y. Supp. 566.

‖ *Oppenheim* vs. *Wolf*, 3 Sandf. Ch. 517; *Gerry* vs. *Post*, 13 How. Pr. 118.

¶ *Estate of Stewart*, 3 N. Y. Supp. 284.

** *Davie* vs. *Briggs*, 97 U. S. 628; In re *Phené's Trust*, L. R. 5 Ch. App. 139; *Nepean* vs. *Doe*, 5 Barn. & Adol. 86; *Nepean* vs. *Knight*, 2 Mees & W. 894; *McCarter* vs. *Camel*, 1 Barb. Ch. 456; *Prudential Assur. Co.* vs. *Edwards*, L. R. 2 App. Cases, 487; Re *Rhodes*, 36 Ch. D. 586; *Matter of Thompson*, L. R. 12 Prob. D. 100; *Whiteley* vs. *Eq. Assur. Co.*, 72 Wis. 170; *Hancock* vs. *Am. L. I. Co.*, 62 Mo. 30; *Johnson* vs. *Merithew*, 80 Me. 111; but see *Burr* vs. *Sim*, 4 Whart. 150; *Whiting* vs. *Nicholl*, 46 Ill. 230; *Naisor* vs. *Brockway*, Rich. Eq. Cas. 449; and cf. *Eagle's Case*, 3 Abb. Pr. 218. See also 91 Am. Dec. 526, note.

of the best-considered decisions; and the authorities to the contrary are comparatively few.

In the determination of problems of survivorship, as in the determination of problems of identity, a wide range has been given by the law to the instrumentalities of proof. In the effort to attain satisfactory evidence of death, the usual rules that govern the admission of testimony have been to a greater or less degree relaxed. Common reputation among the kindred of the deceased;* even hearsay statements †—the declarations of persons who have themselves since died, and who were related by blood or marriage to the missing man—have been deemed admissible evidence both of the fact of death and of the date of its occurrence. In any case involving pedigree, hearsay evidence of deceased members of the family is admissible; and the term "pedigree," within the meaning of the law, embraces not only descent and relationship, but birth, marriage, and death, and the times when those events occurred.‡

Yet, in spite of this latitude of proof, the principles which have become so firmly established in our law as a guide to the determination of questions of survivorship leave, it will be seen, but little opportunity for the application to those questions of the teachings of medical science. In cases where persons have been found dead, the relative degree of putrefaction has not infrequently served as a material guide to the determination of the comparative duration of their lives. In the case of the death of mother and child in childbed, there was, among continental jurists, a strong presumption that the former survived, for there was *prima facie* evidence of still-birth; but many recorded instances attest the fact that an unborn child may in fact survive its mother.§ In some instances, too, where proof of the attendant circumstances of a disaster has been furnished, medical evidence as to the comparative susceptibility to various destructive agencies of the old and the young, of males and of females, may serve to confirm the hypothesis of the survivorship of one from among a number of the victims. Thus, in cases of suffocation, a woman, by reason of a diminished liability to asthma, is presumed, it is said, to survive a man.‖ In cases where persons have been buried alive by earthquake or beneath some fallen weight, the younger, it is said, are likely to survive the older.¶ Yet the probative force of such evidence is weakened by the fact that the conclusions of medical science on these topics are subject to variation through manifold disturbing causes.

Medical testimony, indeed, finds its widest scope not in lieu of, but in aid of, the other agencies of proof. Where men have perished away from human sight, the mystery of the order in which they met their death

* *Morrill* vs. *Foster*, 33 N. H. 379; *Am. Ins. Co.* vs. *Rosenagle*, 77 Pa. St. 507; *Mason* vs. *Fuller*, 45 Vt. 29; *Anderson* vs. *Parker*, 6 Cal. 197; *Dupont* vs. *Davis*, 30 Wis. 170; *Clark* vs. *Owens*, 18 N. Y. 434; *Jackson* vs. *Ety*, 5 Cow. 414.

† *Wilson* vs. *Brownlee*, 24 Ark. 586; 91 Am. Dec. 523; *Jackson* vs. *King*, 5 Cow. 237; *Fulkerson* vs. *Holmes*, 117 U. S. 389, 397; Greenleaf, *Evidence*, vol. i., § 103.

‡ *Eisenlord* vs. *Clum*, 126 N. Y. 552. But where questions of birth, death, age, or relationship are merely incidental to the inquiry, and the controversy is not purely genealogical, hearsay evidence is inadmissible. *Eisenlord* vs. *Clum*, supra, p. 566; *Haines* vs. *Guthrie*, L. R. 13 Q. B. D. 818; see, however, *Wilson* vs. *Brownlee*, 24 Ark. 586; 91 Am. Dec. 523.

§ Wharton and Stillé's *Medical Jurisprudence*, vol. ii., § 1054.

‖ *Ibid.*, § 1025.

¶ *Ibid.*, § 1051.

is one that can never be solved with much assurance of success by any general consideration of medical laws. "The scene," as Judge Church has said, "passes at once beyond the vision of human penetration;" and attempts to solve the mystery leave one but the more impressed with the futility of the effort. A thousand circumstances may be suggested to shatter the theory of the survivorship of the one or the other of the victims. A thousand unknown forces may operate to neutralize the forces on which we had counted and on which our theory had been based; and so our law has said, and wisely, as it seems to me, that the general rules of hygiene will not avail to reveal to us that which no eye has seen and no ear has heard. Those rules find their true application when they are used as corroborative of conclusions that known facts may legitimately yield. They will not of themselves supply the need of proof; they will not of themselves enable us to evolve the known from the unknown.

There are cases, of course, where any determinate rule is better than no rule at all. There are rules like the rule of the road, which, as it has often been observed, might as well be one way as the other; only let the way be certain and defined. And arbitrary presumptions as to survivorship can find their vindication, if they can find it at all, only in some such consideration of the needs and the policy of the law. Yet it is very doubtful whether questions of the comparative duration of the lives of men are such as to demand an artificial and determinate test. Instances of its possible application are hardly numerous enough to make the rule in any event an urgent necessity; and the determination of the property rights of the living by a fixed and arbitrary standard cannot but involve injustice at times to those whose rights are excluded or denied. I can never believe, for my part, that it is wise, unless in matters whose solution is essentially indifferent or where *some* solution is imperatively required, to solve the problems of the law by artificial and formal tests. I can never believe that it is wise to place the doctrines of the law out of relation either to the teachings of experience or to the promptings of reason; and it seems to me that courts of justice, by frankly admitting their inability to solve a problem which in its nature is insoluble, will better promote the ends of their existence than by the forced assumption of a knowledge which it is not given them to have.

HOMICIDE AND WOUNDS.

BY

LEWIS BALCH, M.D., PH.D.

Homicide defined.—The penal code of the State of New York defines homicide as "the killing of one human being by the act, procurement, or omission of another." (Penal Code 179.) The manner of the death, its cause, its time, and the means or weapons, with the wounds found on the body, are all questions properly referred to medical experts, they being questions of which one educated to observe the various phenomena of life and the morbid changes produced by disease or injury is expected to have the special knowledge necessary to aid the course of justice. Homicide by itself will not be further treated, but as it appears in conjunction with the consideration of wounds made with criminal intent.

Wounds defined.—Under the old English law a wound had necessarily to be an injury which in some way divided the true skin. But this would leave out of the category injuries with such weapons as would not cut or divide the skin, and which, nevertheless, would cause death. In surgery, wounds are variously classed as incised, contused, lacerated, gunshot, and punctured or penetrating wounds, while fractures of bone, although done by violence inflicted by another, are placed in a different list, to which is generally added dislocations. I fail to see any good reason why in medical jurisprudence all injuries which are caused by the attack of one person upon another should not be considered as wounds, whether it is a bruise, cut, or break; for in a severe contusion we have injury done to the soft parts, apt to be followed by death of the part so injured, and the consequent danger of septic poisoning as the resultant; and the contusion may cause rupture of an organ such as liver or kidney, which should certainly be considered as a wound. A broken bone, when the break is by violence, in contradistinction to one done for the refracture of a badly united bone, wounds for a greater or lesser extent the muscles at the point of fracture, although the wound does not extend to the outer covering. Likewise a dislocation may cause such a wounding to nerve tissue as to occasion instantaneous death, and yet there be no cutting or tearing of the skin. Scalds and burns are not ordinarily considered in the light of wounds, and are not so if the word is held to mean only a cut or torn condition of the true skin; but they are undoubtedly wounds in a legal sense when inflicted unlawfully. I am inclined, therefore, to consider a wound as an injury produced by violence whereby solution of continuity in hard or soft parts is procured, or where loss of substance from death of the part due to the violence follows its infliction. When

dealing with jurors, medical witnesses must remember they are talking to men who have not made any study of wounds or wounding, and to them the word "wound" carries the impression of some injury caused by a weapon. If the statement made above is then taken as the explanation of a wound, the juror does not have to try and learn the various kinds of wounds presented to medical students for their instruction, but has only to remember the main fact that the wound or injury, whatever its nature, was the one causing the death, could have been inflicted in the manner claimed, and was of such nature or in such position that the dead man could not have made it upon himself. He knows that the injury talked of was a wound, and that is sufficient for him.

Contused Wounds and Ecchymosis.—Wounds made by some blunt instrument may leave such traces as to lead not only to a clear statement as to what kind the instrument was, but also to the perpetrator, as the evidence given by the marks inflicted is shown to be possible only by the use of a particular weapon known to be owned and in the possession of the prisoner at the time the assault was committed. To detail these signs would be an easy task, but it becomes a far different one when such distinctive marks are wanting. A blow from a cane, bludgeon, lead pipe, or other such substance having a smooth surface with rounded edges, gives no clue as to the particular weapon, and the same kind of injury may often be made by falls. It is then only possible for the medical witness to state that such a wound could have been produced by the weapon shown, if the latter is of the character given above.

Wounds of this kind generally give the sign of a bruise, viz., the discoloration of the skin called ecchymosis. When this ecchymosis follows immediately upon the reception of the blow, the color is red or blue, being of deeper tone in its center; and it may not be anything more, for, death resulting from the blow, time is not given for the changes noticed where the ecchymosis passes through certain stages in the living body, going from blue to almost black, then purple, violet, green, yellow, and fading from the last-named color to the natural condition. This is due to the effusion of blood into the skin and cellular tissue from the rupture of capillaries or small vessels; and as the blood ceases to flow and clots, is followed by serum, and that in turn by inflammation, we have the change in color as nature gathers her forces to get rid of this abnormal condition. It is to be remembered that the ecchymosis does not always appear in the spot wounded. It does do so if it appears at once, that is, in a few minutes after the blow is struck; but the bruise does not always show at once, and then the effusion is governed by the resistance given to it and the guidance it receives as to its course by the arrangement of the tissue into which the blood is effused. Thus, when the force of the blow is transmitted to the deeper parts, or when it causes a fracture, the ecchymosis generally appears late, twenty-four to thirty-six hours after the infliction of the injury, and it is also generally at a distance from the seat of the true wound. This may be misleading unless the fact is kept in mind, for one may say when he saw the body there was no bruise upon it, and another may be equally positive the signs of severe bruising were present, for even after death the discoloration from the effused blood will make itself apparent, the laws of gravity and least resistance allowing of the blood forcibly driven from the small blood-vessels at the time of the violence to come to the surface and give the evidence of ecchymosis.

Again, we may have blows where no ecchymosis follows. Contusions of the abdomen, owing to the want of solid support under the tissues, rarely show bruising. These injuries are sometimes so severe that rupture of the internal organs, liver, spleen, and kidneys, takes place, and yet no appearance of injury is visible externally. Falls may give similar results, and cases are reported where vehicles have run over persons, death following in short order, and no injuries which would draw the attention of the uninitiated appearing on the surface of the body. And the condition a body is in at the time a contusion is received has to be taken into account, for what on the person of a trained athlete would leave no trace, would on that of a weak or diseased person cause a bruise of much greater magnitude than would be expected from the force exercised. When death results suddenly from a blow or a fall and no signs of the violence are given externally, it is imperative an autopsy be held, the diagnosis of apoplexy or heart failure being more apt to be erroneous than that death is due to the rupture of an internal organ in consequence of the violence sustained.

Contusions from "sand-bags," a favorite weapon with the criminal class, give no external marks. The sand, being loose in the bag, spreads in it at the moment of contact, and while the force of the blow is not lessened, the yielding nature of the weapon allows of adaptation to the part struck, and does not even stir the cuticle. But the contusion is none the less apparent on dissection, for it partakes of the same character as those of the abdomen, where the effect of the blow is felt in the deeper parts, and ecchymosis may follow in time. Generally these wounds are made to the head or neck; and if not immediately fatal from shock to the nerve centers, are dangerous from subsequent inflammation and from the effusion of blood, which causes pressure on brain or spinal cord.

Has a Given Contused Wound been made on the Living or Dead Body?—It is readily understood that where some swelling of the part struck is present or changes of color at the edges of the bruise have taken place, the contusion was necessarily inflicted during life, for, from what has already been said, after the blood is driven into the skin and its cellular tissues by the force of the blow, the extension of the bruise is due to the effusion of serum from the clotted blood, and this gives the lighter marginal color. Consequently, if such a condition be found on the dead body, the inference is positive that the injury was received during life. But the case is different when there is only the initial evidence of a blow. Here the dark red to blue color is from the blood direct, and as the blow or other causes may be fatal immediately, nature does not go on to give the changes observed in bruises during life, when the absorbents are active. And here comes in the question of time of infliction. If the blow causing the ecchymosis at the same instant causes death, the appearance of the bruise is practically the same as if death had been delayed for a few minutes or even half an hour. Authorities all agree that it is more than doubtful if positive evidence can be given on this point. The experiments of Sir R. Christison showed that even up to two hours after death the appearances made by a blow upon the dead body were apparently equal, and not to be positively told from a bruise of like character in life. The force of the blow, however, on the dead was found to require considerable augmentation to produce a similar appearance to a light blow on the living; but as other evidences would not be present to show

how much force had been used, this point does not help in the decision. The ecchymosis produced by a blow should not be confounded with the discoloration of the skin which follows death, generally called suggillation, but better described by Dr. Taylor as cadaveric lividity. Here the appearances may lead an untrained observer into error, but one having experience with cadavers will not be in doubt, for the general extent to which this cadaveric lividity is found precludes the conclusion that it could be from violence. While, then, the medical witness must use caution in stating that a given bruise is the result of a wound received during life, unless, as has been before said, the changes in it are such as could not have taken place after death, if chance is given for dissection the fact that the effusion of blood is in the skin—though it must be borne in mind that this effusion into the skin does not always take place even in the living—as well as in the cellular tissue, would incline to the opinion that the injury was received before death or just at the time of death.

In the drowned, or in bodies which have begun to putrefy, the passing of an opinion upon marks which appear to be contused wounds becomes even a more doubtful matter. Where the body has been for some time immersed in water and putrefaction has begun, it is found to be swollen, of a greenish-blue sort of color, the cuticle comes off in handling, the superficial veins are enlarged, and show dark, being easily recognized; and a contused wound, or in fact any other kind of a wound, has undergone such changes as to make it impossible on the part of the medical expert to say whether such wound had been received during life or not. One can, from careful examination of the whole body, form a conclusion, but this conclusion can be only a supposition, and cannot be a positive one. The evidence given must therefore be that of what is apparently, from all considerations, the greatest probability, but cannot be positive, or even approaching positiveness.

A condition exists which has been termed pseudo-ecchymosis, resulting in slight abrasions of the cuticle, and giving a yellowish or brown appearance after time has sufficiently elapsed to allow of the abrased surfaces becoming dry. These are to be taken into account in the examination of a body; but as they may be made by the body striking against any hard substance as it falls, either before or after death, alone they cannot be held to be of great significance. The noting of them may, however, have an important bearing in determining whether a struggle has taken place, for the cuticle peels quite easily under pressure, and the position and direction of these erosions may indicate some other cause than a fall. Any one who has been familiar with dissecting-rooms will readily recall many instances where these brownish patches, hard and dry, were seen on cadavers. It is as easy to produce them days after death as it is before death, and the difference between the two cannot be determined. The epidermis, if rubbed off from any cause, gives such a condition as the result. It may be said if the excoriation is a shade deeper than the cuticle, enough to cause slight abrasion of the true skin and draw blood, the result is a scab, as it is ordinarily called, and this would only be present during life. If a similar abrasion was made after death, the part would be a darker brown and probably harder than where only the epidermis had been removed, and in this way it might fairly be distinguished as to time of infliction. The scab would not, however, be the result if the abrasion was made at the time of death. It would re-

quire from one to two hours for formation, and so if such an excoriation was due to violence, when death was the immediate result, the appearance would be the same as if made after life was extinct.

Where fractures result from blows, the skin not being broken, the ecchymosis not only is not always immediate, but may make its appearance at some distance from the seat of the injury. Generally it would be expected that a blow strong enough to cause fracture would also cause a bruise at the place struck, and this is true if the wound be made with some weapon such as a club, billy, or other hard substance. But if it is made with a softer substance, as a sand-bag, the result may be identical with the conditions noticed in fractures by indirect violence. Unless there be some such external evidence to show the wound was made during life, the presence of the break does not allow of positive statement as to the time it took place, for a fracture made in the dead body at or shortly after death, before animal heat has departed, gives the same appearance as one made just before death, the muscles surrounding the bone being similarly torn, and blood effused in the laceration in the same manner as it is during life. If the fracture is made some hours after death, when the body temperature is notably lowered, then we do not have as marked a condition as in the other cases, for here the blood effused is not so much as when animal heat is still present, unless a vein is torn, and the ruptured muscles do not give the appearance of sudden tearing.

It is hardly necessary to call attention to the different discolorations of the skin produced in eruptive diseases, such as the dark purplish spots of typhus fever, scurvy, etc. Any of these petechiæ should be readily recognized by the physician as not the products of violence, and the history of the case will aid in the diagnosis. The appearance after death of purpuric spots is very similar to that of a bruise produced at the time of death, but their size and general connection, combined with the fact that similar spots are to be found in the mucous membrane of the throat and alimentary canal, will prevent the examiner from confounding them with ecchymoses resulting from violence. In old people it is common to find dark spots or patches on the extremities, sometimes enveloping the whole of the limb, which are due to imperfect capillary circulation, and which might be mistaken after death for bruises. The seat of these, however, they being almost invariably on the lower part of the leg, and their character, will show their true nature. It is but necessary to call attention to these different simulations of ecchymosis to put the medical examiner on his guard.

Wounds by Cutting Instruments.—In describing all wounds, of whatever nature, where the person to whom the description is given is not of the medical profession, it is best to use ordinary plain language, avoiding all technicalities. This saves the trouble of explaining what is meant, and allows those hearing the statement to understand its import, they not being required to do any hard thinking over unaccustomed word sounds, and so lose the thread of the tale and the sense of what follows the scientific phrase. And in describing the position of wounds on the body, the medical witness should endeavor to use the simplest of language and the shortest of descriptions compatible with clearness. To too minutely describe every abrasion, bruise, scratch, cut, fracture, or any other mark of violence that may be found on the body, is to burden the mind of the jury with much that may far better be condensed into

collective statements, which not only prove less tedious but also much clearer to the listeners. By this is not meant that careful note should not be taken of every mark and its location defined, as well as its probable cause and probable time of reception, but that where many similar injuries—small bruises, for instance—are found over the body, it may be stated in one sentence, one having been fully described, as "so many similar bruises, on the body, arm, leg," or wherever the situation may be.

Cut or incised wounds are those made by an instrument possessing an edge which will divide the integument as it is drawn across or pushed into it, as in stabs made with knives. The instrument may be a piece of glass, tin, or sheet-iron, and the wound resulting be a cut, although, as a general rule, in homicidal wounding axes, hatchets, swords, knives, and such like weapons are used. All these have cutting edges, and make wounds very similar in appearance. When an ax or hatchet is used, while the edge cuts, at the same time the weapon delivers a blow, and to the cut may be added the breaking of bone, or, if the weapon be dull, the appearance of a lacerated or torn wound rather than one incised. As in contused wounds, so in cut ones: if the wound has been made during life and sufficient time given for reparative process to begin, the telling of when it was inflicted, or a fairly approximate period, is not so difficult a matter. If the signs of the inflammatory healing process are present, or if adhesion of part of the wound has taken place, the surrounding tissues a little swollen, or if pus be found, we know the wound was made during life. But the wound may be a mortal one, and the victim pass instantly from life to death. Here, then, is a condition with other phenomena, and one requiring careful examination to give a definite statement upon. The wound being a cut, if made upon the living body as a general rule it presents the characteristics of gaping, the skin being a little everted, showing the deeper tissues, while blood is freely poured forth, especially if an artery has been wounded, and clots of blood are found lying in the cut. The skin is highly elastic, and when severed while alive, draws away from the line of incision; and if the cut is transverse to muscular fiber, more gaping is noticed, on account of the contraction of the divided muscles, than when the wound is in the line of the muscle. In a transverse cut is found not only more gaping, but more bleeding takes place than when the cut is longitudinal. The blood, being fresh, will coagulate where it falls, and if an artery has been involved with a chance to discharge its blood in spurts, traces of this sort of bleeding will be seen on the clothes or on the body, and may also be found on walls, floor, furniture, or other articles within reach of the spurting vessel. This was well shown in a case of a gentleman who lived in Albany, N. Y. Having had an operation performed for cataract, the day he was told his sight would be tried having arrived, he anticipated the visit of the doctor, and while the family were at church got out of bed, made his way to a shaving-stand in the room, and took off the bandages. Not finding his sight as much improved as he expected, he took a razor from the drawer of the stand and cut his throat, severing the left carotid. The stand, its glass, and the wall above and on either side were spattered with blood, spots reaching as high as six or seven feet. The man himself was about five feet ten, and was also bloody to a great degree.

The blood-marks from an incised wound, therefore, may be an important factor, aiding the decision of whether the wound was before or

after death where the wound is a cut. If, however, the wound is a stab, and but the size of the blade making it, no vessel being severed in its course, the appearance of the wound may be such as to make the examiner hesitate as to its time of infliction. Casper relates a case where a man stabbed his wife in the breast, causing instant death by the severance of the aorta, and yet the wound through the chest walls showed no sign of bleeding, and was to all appearances identical with a wound made upon the cadaver. The autopsy will do much to clear up any doubt in wounds of this character. If no other condition can be found to which death could possibly be ascribed, and a mortal wound is discovered, the logical inference can only be that it was made before death and was the cause of death. For if the wound had been made after death, unless the cause be shock, some evidence of other destroying means would be seen, and then the study of not only the wound itself, but the deductions to be drawn from the internal evidences, would be the guides to a conclusion as to whether death was prior to the wounding or not. As, for instance, where a throat has been cut to simulate suicide and hide the crime of murder by suffocation. Here we have a wound which may give all the signs of having been made during life with the exception of one, viz., the bleeding, and the autopsy would find the characteristic evidences of death from suffocation. The wound would bleed freely, but the absence of arterial action, the very fluidity of the blood, combined with the other post-mortem appearances of death from interference with respiration, would lead the examiner to the conclusion of homicide, and that the cut was made after death.

A wound made immediately after death will present the same appearances as a wound made before, but the hemorrhage will be different, and, unless some large vein has been cut, not so copious. We may even find coagula in the wound and the gaping and evected edges if infliction has been done before the elasticity of the skin is lost; but the bleeding is venous and follows the laws of gravity, does not spread so widely as when the heart still acted, even if it gave but one or two beats; and this fact of itself calls for most careful search. While it is possible, as in the case quoted from Casper, that a mortal wound may present only the appearance of one made on the dead, if the wound has been made on the body after death has been established for half an hour or more and the death could be attributed to another cause, such as a blow upon the head, the question of the wound having been made on the living would properly be decided in the negative, the majority of evidence pointing to another cause for death, and all the appearances of the cut being those of wounds on the cadaver. Still doubt might be raised, for the wound to the head might be such as could be received by the body falling; and as the fall would be simultaneous with the wound and with the death, the question of which injury took life would be one of difficulty. I consider great stress should be laid upon the hemorrhage from the wound, for the heart is the last part of man to die, and while its action may be feeble by reason of the nature of the injury, if the cut was made before death took place more bleeding could properly be expected, and, as said before, of an arterial character. In 1859, at Lyon's Falls, N. Y., a Mrs. Priscilla Budge was found dead in bed, cold, and with her throat cut. Her husband, the Rev. Mr. Budge, was arrested for murder, but the verdict of acquittal was rendered by direction of the judge, as clever cross-

examination of counsel had confused one of the people's medical experts, and if the statements he made were correct, conviction could only be had on probabilities. The evidence, however, of the body and its surroundings, as reported by Dr. Swinburne, showed a transverse cut of the throat, below the thyroid and severing the cricoid cartilage, going so deep on the left side as to cut the transverse process of the fifth cervical vertebra, the periosteum and substance of the vertebra also cut, and then the soft parts of the right side of the neck. The cut was evidently from right to left, from the manner of its beginning and ending, and the bedclothes, which were undisturbed, as well as the nightdress of the woman, were free from blood. Blood had flowed from both sides of the wound down the neck and soaked the mattress. There was no spattering of blood anywhere, and the defense was suicide while in bed, the weapon being a razor found lying near the right hand. The autopsy, which was not held until four months after death, but which, owing to the winter weather, hard frost, and character of soil in which the body was buried, was still a valuable autopsy, gave the signs of death from suffocation. The appearances of the wound as the woman lay in bed were in every way the same as if it had been made during life. The only difference was that the blood flowed by gravity, and was not thrown forcibly by the per saltem action of the heart. Had the medical man who first saw the case been familiar with the rudiments of medical jurisprudence or been a close observer, the fact that there was an absence of blood over the bed, walls, floor, face, hands, or anywhere else that a live artery could throw it, he would not have been so ready to consider the case one of suicide, but would have made proper examination of the body for other cause of death. Comparing this case with the one of throat-cutting previously quoted, the immediate difference is noted: the body living and but one carotid severed, the walls, shaving-stand, floor, everything around covered with blood; the body dead, heavy oozing of blood, flowing in the line of gravity, no spattering of spots anywhere about.

Lacerated Wounds.—These may be caused by other than sharp instruments, or even by them, for the injury is where the wound is torn and not clean cut. A marked feature is, they are generally attended with but little hemorrhage, the vessels being severed by tearing, the ragged edges entangle the blood so it rapidly clots, and prevents further bleeding. A limb may be torn completely off and not so much hemorrhage follow as would from a severe cut. Still, death from bleeding as the result of a lacerated wound can and does take place. The chief danger, however, is from the extent of the injury and the shock to the nervous system. The appearance of a lacerated wound made during life, unless it is of some days' standing, is not to be distinguished from one made immediately or shortly after death. Coagula are found in the wound in both cases, for, as shown above, the blood does not lose its power of coagulation until the body has lost its heat. Consequently, if the wound is made near to the time of death the blood effused will be found more or less clotted in it. And the arteries being torn, we do not have the free spurting seen when they are cleanly cut. The evidence to be relied upon as to the wound having been made upon the living is chiefly the history of the case to be obtained from those who first saw the body. Naturally, if witnesses of the wounding can be found the question is easy of solution; but where none such are obtainable the de

cision has to be very guarded, nothing being positive about the wound itself.

An injury of this nature may present some of the characteristics of one incised, for a blow delivered on a part under which lies a ridge of bone, while not causing the cut by the weapon, may by the force cause a division of the skin and subsequent parts by the power with which they are driven upon the bony ridge or protuberance. And thus made, the cut may appear more like an incised wound. A similar result may be obtained where the bone under the tissue struck is smooth, for if the tissue is not thick the force of the blow may cause a wound sufficiently clean cut in character to allow of an artery divided in it to spurt blood to quite a distance. In the case of O'Shea, tried for the murder of his wife in Washington County, N. Y., in 1881, evidence was presented of a fight between the two, and lacerated and contused wounds were found on the woman in different positions. The three principal ones were: first, over the right eye, severing the anterior branch of the temporal artery; second, on the back of the head below the occipital protuberance; and third, on the left lower jaw, probably cutting the facial artery where it crosses the body of the bone. The woman was found dead in her bed in a small room, and blood in spots was noted on the walls, windows, and ceiling, as well as on the bed and floor. It was claimed by the people that these blood-spots were from the cut over the eye, and it was shown the distance they had to be thrown was from three to five feet. From the body, as it lay on the bed, to the ceiling was about four feet, and it was claimed that the temporal artery could throw the blood up to the ceiling from the bed. The woman's hair was done up in a knot behind her head, the ends of which, however, hung loose, and were wet with blood. It was claimed by the defense that the spots were more liable to come from blood being thrown from these ends of hair in the fight which took place, as the artery could not, in all probability, have sufficient force to raise a jet of blood four feet. It was a drunken brawl, and the jury brought in a verdict of murder in the second degree. In this case the wounds were all lacerated and contused, and yet hemorrhage to a considerable amount took place. I am more inclined to the belief that the spots of blood on ceiling and walls, especially if they reached their destination from a distance of four to five feet, were more probably caused by the flirting of the hair in the struggle, than directly from the artery, especially as a few weeks after the trial I saw a case where a young man had been cut in exactly the same spot on the right forehead by a brick thrown with force, which caused a clean, lacerated wound, allowing the anterior branch of the temporal to give characteristic arterial hemorrhage. In this case the man was standing, for the blow did not knock him down or render him insensible, and the extreme distance to which the artery threw the blood was three and a quarter feet, and when I saw the case the vessel was still bleeding, though not with such force.

From the foregoing it will be seen that as much care must be exercised by the medical examiner in passing judgment upon a lacerated wound as upon one incised, supposing the former to have been made during life. In the case cited small wounds have been given as examples. If, however, large arteries are cut by the blow of the bludgeon or other blunt weapon and the wound be fairly sharp in outline, the bleeding may be more that of an incised wound than a torn one, and caution is neces-

sary, for the wound may be the direct cause of death; and yet if it is considered to be an incised one, it is not sufficient to be fatal, the concussion from the blow making the wound being the death producer, the wound being but an additional injury and not one which would be considered dangerous to life.

Gunshot Wounds.—This class of injuries are generally produced by missiles, chiefly lead, fired from some sort of pistol or gun, the propelling force being powder. And this is in fact what one mainly meets in legal practice; but it is still to be remembered that the same character of wound may be made by any projectile, no matter of what it is composed, and no matter what the propelling force. As, for example, a small stone or pebble, resembling a bullet in size, thrown by a blast or any sufficient force, will give what is technically known as a gunshot wound, and it is such a wound, only not one caused by the use of fire-arms.

Where the injury is by a bullet fired from a gun or rifle we have certain characteristics which are common to this class of wounds. The effect of a ball striking the soft tissues of the human body is, first, that of contusion, and the degree of this contusion is in proportion to the velocity of the bullet. Ordinarily, when traveling at the usual velocity, a bullet does not at first sight appear to have bruised the tissues, but the force is so great, the speed is so swift, the contusion reaches the point of disintegration of the tissue struck, and we see but the open wound of entrance and the corresponding one of exit. The track is open in all its course, for the contusion was so strong the tissue in the course of the ball was rapidly and instantaneously reduced to a pulp. Shreds of it may lie in the course of the wound, but what remains is dead tissue, all life having been done away with by the terrible force of the blow. There is added to a gunshot injury, which of itself may not be dangerous either from the part shot or the amount of blood lost, the factor of sloughing and the healing by second intention, and a slight wound may under these considerations become a dangerous one. The contusion is so complete and the time of the bruising force so short that the surrounding parts are not involved, and ecchymosis is rarely seen. It is different, however, if the ball is a spent one or one traveling at a very low rate of velocity. Here the skin may not be broken and the contusion constitutes all the wounding, although that contusion may have deep effects, and bruise internal organs in a way to cause death. The signs externally would be the ones already described in other like wounds made by any blunt, hard instrument, and the size and appearance of the bruise would be in accord with the missile making it.

When a bullet has entered or traverses a body, supposing it does not touch bone, its track may be followed on dissection and shown as a blood-stained line, as well as the openings in the various tissues penetrated. If the recipient has survived the wound a few days, two or three, while the track is then not an open one, it is nevertheless as easily followed, for slight inflammation having by this time started in the course of the ball, the sharp red line is plainly seen against the other tissues. If bone be struck, something more happens, for the bullet, being of soft lead, is more or less "upset," as the saying is, and if it penetrates the bone it loses some of its lead by attrition. The fracture thus caused is generally radiating in character. The ball may disintegrate bone in the same way it does the soft parts, especially when the bone struck is of

hard and brittle constituency. And when this is the case, the ball loses even more of its lead than when merely piercing a bone or lodging in one.

In these days the majority of fire-arms throwing bullets are rifled, and the ammunition used is called "fixed," from the fact that ball and cartridge form one package, the cartridge-shell being of metal and the ball being set firmly in it direct upon the powder, wads being no longer interposed between the two. These facts alter somewhat our dealings with this class of wounds. Formerly, when smooth-bore muskets and pistols were in common use, with round balls, as such weapons gave but a low velocity and comparatively small penetrating power, a bullet was often deflected by encountering bone or even by tendons, when these were struck at an acute angle, and the bullet changed its course in the body. I do not mean to say bullets from rifled weapons are never deflected, but their higher rate of speed, their greater power of penetration, the form of the ball being long and pointed, the rotary motion imparted by the rifling of the barrel, tend rather to send the bullet in a straight line to its destination, boring its way through bone or all obstacles, than to let it be turned one way or another by tissues lying in its course. And this should be remembered, for it may have an important bearing in the opinion expressed on a given wound as to its danger.

In the early eighties a man was shot at Fonda, N. Y., in the neck, left side Three days afterward he was paralyzed on the right side, and died in about a week. The surgeon in attendance supposed from the paralysis being on the right side that the bullet had turned on the transverse process or on the bodies of the cervical vertebræ, probed further for the ball, and his probe passed easily its entire length up toward the head. At the autopsy, however, he found no wound or clot or other injury to the brain, and then began dissecting the neck, following the wound of entrance. In a straight line from where the bullet entered it passed to lodge between the fifth and sixth vertebræ, cutting the left vertebral artery completely in two. The cause of the paralysis was then apparent. The weapon used was a small revolver, but with rifled barrel and conoidal ball.

Wounds made by shot-guns, unless they are loaded with buckshot or ball, depend upon the distance from which the shot was fired for their appearance. If fired at close range, before the charge of shot has had time to separate a tearing wound of large size is made. The edges are not as clean as when a rifle-ball has entered, for the charge is not a compact one. If fired from a greater distance, then we find shot in a larger area, some deeper than others in penetration, and the shot go in singly or in groups, depending on how carefully they were put into the cartridge. If not fatal outright and if not entering a cavity, the wounds are dangerous only from the inflammation that may follow.

Gunshot wounds may be fatal without any external mark, for the weapons may be discharged into the mouth, or the bullet may enter by the vulva or anus. During the War of the Rebellion, a general officer of the Federal forces, riding in a fog up to a picket, discovered it to be the enemy. He wheeled his horse, and leaning down on him as far as possible, drove in the spurs. The picket fired a volley. The general's horse carried him into our lines, but the general was dead. A bullet had entered the anus, leaving no mark of its entrance, and ended its course in the thorax.

Marks of Discharge upon Clothing or Skin.—To burn all the powder used as an ordinary charge, a gun would have to have a barrel about fourteen feet long. The "flash" of fire-arms so eloquently written about is from particles or grains of burning powder not fully consumed. The smoke is from that part of the powder completely burned. It is clear, then, that the burning grains will cause fire-marks on clothes or skin if the discharge is near enough to the body. The distance the muzzle of the piece has to be from the body depends upon the kind of arm used, its caliber and charge. All vary, and experiments made with the alleged weapons are the only guides which can be truly relied on. In general, it may be said the muzzle must be almost touching for burns of clothing or skin to be present, but here again we find some cloths take fire more readily than others. The skin is more uniform in this particular, and burning of it, or the numerous implantations of powder-marks, shows the weapon to have been held within a short distance.

In 1883 a man named Heigham shot another to death in Watertown, Jefferson County. Self-defense was claimed, and the distance the weapon was from the body when the shot was fired became an important question in the case. As part of the evidence to decide this question was how far powder would be implanted in the skin, the subject was referred to Dr. James D. Spencer, of Watertown, one of the medical experts for the people. The doctor consulted me, and together we made certain experiments to see how far the weapon, described in the notes as an "English bull-dog pistol, self-cocking, .32-inch caliber, 9 grains of powder, 88 grains of lead, made by Smith & Weston," would carry unburned powder and plant it in human cuticle. On the 8th of December, 1883, in the dissecting-room of the Albany Medical College, we fired at a piece of skin which had been taken from a fairly fresh subject, and which is described as having been "nine inches square, with cadaveric rigidity." Shots were also fired at cloth. The notes say:

No. of Shot.	Distance.	Direction.	Result.
		Skin.	
1	6 feet.	Direct.	Powder too numerous to count. Flashed.
2	8 "	"	25 to 30 grains. Flashed.
3	10 "	"	8 to 12 " "
		Scalp with Coarse Hair.	
1	2 feet.	Direct.	Hair singed.
2	2 "	"	" "
3	3 "	"	" "
4	3 "	"	" "
5	3 "	"	" "
		On Cloth of Coat.	
1	4 feet.	Direct.	Lubricant on cloth around bullet-hole.
		Two Cloths over Cotton Shirt, Undershirt, and Skin.	
1	5 feet.	Direct.	Lubricant around bullet-hole.
2	4 "	"	" " "
3	6 "	"	" " "
4, twice	7 "	"	" " "
5, "	8 "	"	" " "
6, thrice	10 "	"	" " "
7, "	10 "	"	Original cloth over skin torn; bullet-hole; no lubricant.
8, "	10 "	"	Same as No. 7.

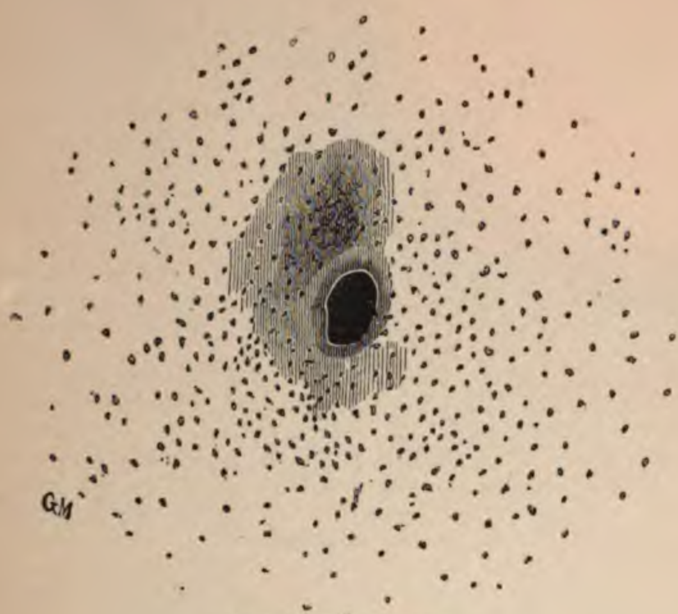


Fig. 61.—13 Centimeters.

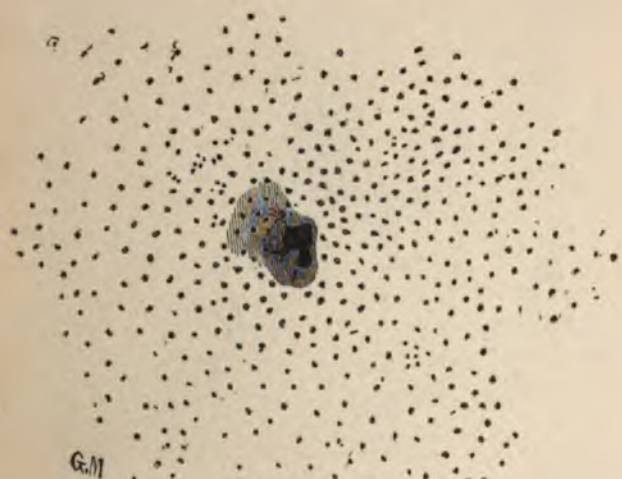


Fig. 62.—20 Centimeters.

Powder tattoo-marks made by revolver at various distances. (Tourdes.)

Fig. 63.—[illegible] Centimeters.

Fig. 64.—96 Centimeters.

Powder tattoo-marks made by revolver at various distances. (Tourdes.)

On December 25th further experiments were made in the same place on human skin.

No. of Shot.	Distance.	Direction.	Powder-marks and lubricant.	Flashed.
1	7 feet.	Direct.	25 to 30 powder.	Yes.
2	6 "	"	25 to 30 "	"
3	5 "	"	15 to 20 "	"
4	5 "	"	15 to 20 "	"
5	4 "	"	Too numerous to count.	"
6	3 "	"	" " "	"
7	3 "	Oblique.	" " "	"
8	4 "	"	" " "	"

Experiments were then made as to powder-marks on cloth in frames with canton-flannel behind at the armory of the Tenth Battalion, N. G. S. N. Y.

No. of Shot.	Distance.	Direction.	Result.
1	6 feet.	Oblique.	Lubricant on cloth and frame.
2	5 "	"	" " "
3	4 "	"	Lubricant on cloth and frame, and powder-marks.
5	2 "	"	" " " " "
6	1 foot.	"	" " " " "
7	6 feet.	Direct.	Lubricant on cloth and frame.
8	5 "	"	" " "
9	4 "	"	" " "
10	3 "	"	" " "
11	2 "	"	Lubricant on cloth and frame, and powder-marks.
12	1 foot.	"	" " " " "

From one to five feet, some scorching.

Further experiments to determine radius of powder-marks. Paper was fired at so stretched as to allow of a smooth surface.

No. of Shot.	Distance.	Direction.	Radius.	Result.
1	6 feet.	Direct.	2 feet.	Powder too numerous to count.
2	5 "	"	2 "	" " "
3	4 "	"	18 inches.	Paper scorched.
4	2 "	"	Most in 12 inches.	" "
5	1 foot.	"	" 12 "	Paper scorched; fire.

Powder was driven through paper in all experiments.

While these experiments are valuable, it must be remembered they are the results of only one kind of fire-arm. Another pistol of the same caliber but with a longer barrel would show differently, or if the caliber were smaller, variations would be found. They give, however, some idea of what may be expected of fire-arms in general.

Gunshot wounds on the dead body give the same appearance as in the living. The only difference may be bleeding, for on the cadaver, unless the bullet cut a vein, no bleeding follows the shot. The size of the wound on the dead does not differ from ones made in life. The entrances and exits bear about the same relation to each other, and in all other respects, to give an opinion only on the evidence of the orifices, without taking every circumstance obtainable into consideration, would be to give but negative testimony. The track of the wound internally in the dead body, unless, as said before, the bullet had traversed a vein,

would not give the same color from blood-staining as we find in like wounds before death. While practice and care may make the distinction, it is not one that can be considered as positive proof, although it may aid in the conclusion when coupled with other revelations of the autopsy.

Self-inflicted Gunshot Wounds.—To state that a given wound could not be made upon a body by the person himself is to put one side the known peculiarities of suicides. The most improbable means as well as the most unexpected methods are practiced at times by those bent on self-destruction. One fact is generally present, and that is, where determination to die is the cause of inflicting a wound, what is supposed to be a vital spot is always chosen, into which the shot is discharged. And the pistol or gun is more apt to be held near than to be fired from a distance. The results of near fire would then be present, and, added to other circumstances, show the wound to have been self-inflicted.

Wounds may be given with fire-arms which, while fatal, are entirely accidental. One often sees accounts of such accidents to sportsmen, who in carelessly handling their guns receive dangerous or fatal injuries, or who, in some careless way, shoot a companion. In wounds of this kind, while the wound itself may have all the appearance of being homicidal and not accidental, surrounding circumstances have much weight. A man found dead from a gunshot wound in the back, murder would not be thought of if he was out shooting, and his gun was found hanging in a hedge or close by a fence which gave evidences of having been passed by the man himself. Wounds of this character may not be so close as to give burning or bruising, but attendant proof will show how they came to be inflicted.

Danger and Severity of Wounds.—If one considers that any injury done to a human body, from chances of inflammation or absorption of some septic matter, or on account of a speculative condition of the wounded that he may have disease of the kidneys, stomach, or what not, prove in time a dangerous injury, all assailants, no matter what the result of their assault, should be confined until such time as all remote danger from whatever cause is entirely removed. The law, however, does not so hold, and medical men should be able to place some fair limit to the danger zone, as they must be able to state why a given injury is dangerous to life.

Wounds which involve cavities like the chest or abdomen, cut large vessels, cause great laceration or crushing of soft tissues, create compound fractures of the larger bones, contuse or fracture the skull or spinal column so the nerve tissues are directly injured—in short, any wound that does such grave harm that the danger to life is imminent, is one upon which the prisoner would be held until the issue as to life or death is decided. It is well known that even slight wounds, cuts, or lacerations may be attacked by erysipelas and the patient die, but the "maybe's" are not to be taken into consideration, unless the chance of their developing is almost immediate; the "is" is what must decide the question. A kick or severe blow to the abdomen would have to be judged by the condition of the patient just after the receipt of the injury, and the physician would properly state that such an injury, judging from the collapsed state of the patient, was one he could not give a positive statement upon as to its danger, but must wait two or three days to determine if internal lesion of serious character had not been done. Here,

then, reasonable time is taken, and taken because of the alarming condition of the patient shortly after his receiving the injury. In the case of a man suffering concussion of the brain and insensible, the surgeon gives his opinion at once that the wound is dangerous to life. In the case of the blow to the abdomen, the patient not insensible, but evidently badly hurt, he takes a reasonable time and states his reasons therefor.

A wound may not be immediately dangerous to life and yet be a serious wounding, one which may become dangerous in a few hours, or may not assume any such change. Here the committing magistrate is to be guided by the requirements of the law, the doctor merely stating the wound is a serious one, but if nothing out of the ordinary occurs, it is not necessarily dangerous to life. The medical opinion must not only be founded upon the nature of the injury, but also upon the condition and history of the patient, for what would only be a severe wound in one person would be a dangerous one in another, and the surgeon's knowledge of his profession enables him to differentiate between the two. It may be a difficult and trying position for the medical man, and one where, whichever way he decides, he may be severely criticised; but, "for this we are doctors."

Evidence of Wounds, Weapons, and other Articles.—After the examination of a body dead under circumstances which call for legal investigation, the medical examiner has to make deductions from all the different appearances of the case as to the questions, Was the death from homicide, suicide, or accident? To do this, everything about the body and the wounds must be carefully noted, and the weight due each in the general summation carefully balanced. The question will be asked, Was there a weapon used, and if so, what kind of a weapon? This is to be answered from the evidences of the wound itself, the clothing, and the autopsy. Where death is from an incised wound the character of the cut indicates the knife. In the case of Mrs. Budge, already cited, the defense claimed her throat was cut by the razor found on the bed near to her right hand. The wound was undoubtedly an incised one, and it is described as being "on the right side, three and one half inches below the lobe of the ear; on the left side, about three and one quarter inches below lobe of ear; four and one half inches below center of chin on medium curved line, severing the cricoid cartilage, œsophagus, arteries, veins, pneumo-gastric nerves, and all the muscles of the anterior part of the neck. Circumference of neck above, or at the wound, twelve inches; curved length of cut, five and one half inches. Depth of cut in a direct line, two inches back to the vertebræ, cutting through the periosteum and into the osseous matter of the fifth vertebra, and also shaving off a lateral portion of the transverse process of this vertebra. Skin on the right side cut down one half to three quarters of an inch lower than tissue. Tissue on left side cut deeper than skin about one half to three quarters of an inch, and extending down into the muscles external to the vertebræ, so that the skin at the termination of the cut on the left side appeared as if stretched and rounded instead of being sharp, or angular. Trachea and tissues retracted, so that wound gaped about two inches." It was claimed by defense the death was suicidal, but the evidence of the wound puts this assertion in doubt. It is to be noticed on the right side the skin is cut further than the muscles, the incision tails off in the skin. To do this the knife must have been drawn gradually

from the cut. On the right side, however, the skin is not cut as far as are the muscles underneath it by half an inch. From what has been said before, the first evidence of this wound would be that it started on the right side and finished on the left, for the known elasticity of the skin gives this evidence. It is divided first at the beginning of the incision before the knife sinks into deeper tissue, as is always the case unless the knife be plunged in at right angles to the surface as deep as it is intended the incision should be made, and then drawn on. At the left end of the incision we have the skin divided less than the deeper tissues. It yields before the force of the knife, and resumes its position after the force is withdrawn.

The wound tells more. It goes down to the backbone, strikes and shaves off a portion of the transverse process of one of the vertebræ, then sinks a little into its body; and when released from this hard, resisting substance, suddenly sinks deeper on the left side than it did on the right in the softer tissues, cutting them beyond where the skin is divided. The evidence of the wound, clean cut and evidently made with one stroke, points to strong muscular effort and a strong-bladed knife as well. Could a cut of this nature be made from left to right, be made by a not over-powerful woman as she lay in bed, and with a razor? The evidence of the razor should be noted. It was but little bloody, and not nicked. Could the highly tempered blade of a razor cut through a transverse process and into a vertebral body and not be nicked or broken on its edge? And finally, could such a wound be made by a razor in the manner this wound was, the cut to start on the left side? Would the woman have the strength to finish such a cut as is described on the right side, after cutting so deeply on the left? Would there be sufficient muscular power left to cut a transverse process after severing the carotid, jugular, and pneumo-gastric nerve on the left side? All the evidences of the wound and the alleged weapon point to another conclusion. The razor could not have made such a wound and remain intact in cutting-edge. It would have been almost impossible to begin the cut with a razor in the manner this cut is described as found on the left side of the neck. And strength could not have remained long enough after the left wound to have made the right. The cut clearly started from right to left, was done by great force, and with some knife strong enough to stand such usage. The evidence presented by the wound negatives, therefore, the theory of suicide.

On August 5, 1873, the body of John D. Weston was found dead on a farm near Albany, N. Y. Weston was an old soldier, who had lost his left arm. Emil Lowenstein, who had been a friend and who was seen in company with him, was arrested as the one who had committed the crime. The body not being found until two days after death, and having during that time been exposed to the weather, was pretty well decomposed. The autopsy was held on the 8th, and the following wounds were discovered: an incised wound of throat, about five inches long, just above the thyroid cartilage and extending two inches to the left and three to the right of the median line, dividing no large vessels. No mention is made as to the edge of this wound, or whether it presented any evidence of having been made from left to right or *vice versâ;* the coroner described it as "fly-blown" when he was called to see the body where it lay in the wood. Along the left side of the face another cut, which merely penetrated the

skin, and corresponded to the line of the jaw. A trifle to the left of the median line and an inch above the eyebrow, almost in the center of the forehead, was an oblong opening or wound which penetrated the skull, and was apparently made by two bullets. Following this, two balls were found in the substance of the brain far back, having nearly gone through the brain. The wound of entrance was a little more than half an inch in one direction and a little less than half an inch in the other. Another gunshot wound was found, about two inches to the left and somewhat above the line of the first mentioned. The bullet in this wound did not penetrate the cavity, but was found flattened against the bone. At the termination of the left eyebrow, internally, a ball had entered and penetrated about a quarter way through the skull wall. Behind and at lower edge of left ear another bullet wound, which led downward into the muscles of the neck. In this case the ball was not found. About two inches behind right ear was another wound, evidently also from the same pistol, and here the ball was found in contact with the skull and more flattened than the one before mentioned. On left side of chest and slightly to the left and above the nipple a small wound, like a bullet wound. The ball for this was not found. Its course was traced, however, for about twelve inches downward and toward the back. A little lower down and more toward the center of the body, in the fourth intercostal space, there was found another gunshot wound of entrance. Following this, the ball was found to have passed through the heart and lower lobe of the right lung, and was recovered in the right pleural cavity. The man had lost his left arm, it having been amputated near to the shoulder. In the back of the right hand another bullet wound was seen, entering opposite the metacarpal bone of the middle finger, which was broken, and passing forward to the base of the thumb, where it was lodged. The track of a bullet was found leading to the right upper jaw from below and to the left. It was supposed this ball had entered the left side of the neck and passed upward, but neither wound of entrance nor ball were found. From the amount of blood in the chest cavities the wound in the breast was considered to have been made during life. No powder-marks or burning of tissue were present about any of the gunshot injuries.

In this case the evidence of the wounds is perfectly conclusive that they were not self-inflicted. While it is true, as will be referred to further on, that wounds of the heart are not necessarily immediately fatal, it is not compatible with any theory, even supposing the deceased had first cut his throat, and then, not finding that wound sufficient, shot himself, he could have inflicted all the wounds found before muscular power had deserted him. The wound through the heart was not described minutely as to what part of that organ was traversed by the bullet; but it was so cut that blood in large quantities was poured out, sufficient to convince the gentlemen making the autopsy the wounding had taken place during life. The evidence of this particular wound was that it was fired from above down, and from left to right, for it entered between the fourth and fifth ribs, passed through the breast and lower lobe of the right lung, being recovered in the right pleural cavity. This is a wound a person could make upon himself, and there need be no evidences of the weapon being held so close to the body as to give powder-marks on the skin or edge of the wound; for a man could so hold a pistol of small

size—and later in the trial evidence was adduced to prove the weapon was of this sort—as to send a ball in this general direction. The probabilities are, however, against such a theory, for it would be not only more natural, but easier, to hold the weapon more at right angles to the chest than to use the strained position such a shot would require, the right hand being used. The shot which entered the heart might not have proved instantly fatal, and one or more of the other wounds could have been made. But suicides generally strike for vital points, and it is not compatible with known laws of injuries to nerve tissue that two shots could be fired, by the person taking his life, into the brain, as were found in this case, going in from the forehead. One such bullet would in all human probability produce instant insensibility, and the hand would not have been able to give the second shot. Other positive evidences of homicide were present. It has already been said the deceased had only his right arm, and a bullet wound and the ball were found in the back of the right hand. This would of itself be positive evidence of murder, for it would be impossible that this shot could have been self-inflicted.

The body was too far advanced in decomposition to decide which wounds were made before or after death, and on account of this the evidences to be deduced from the incised wound of the neck are nil. A razor found near the body, from its blood-stained condition, was evidently the cutting instrument. No pistol was found, but one was recovered from the prisoner which could have fired the bullets taken from the body. The prisoner was convicted and executed.

In the summer of 1879 one Briggs, a farmer living at the lower border of Albany County, was arrested for the killing of a man named Woods, employed by him as general utility man about the farm. Briggs, having had his suspicions aroused concerning the relations of his wife and Woods, determined to investigate, and stating he would be away on business for a few days, left his farm. He did go away, but returned secretly in the night, and entered the general living-room by means of a window. Off of this room, opposite to the window by which he climbed in, were two small bedrooms, one of which was occupied by Mrs. Briggs. The door of this room was open, and was also the nearer to the door leading into the front hall. The weather being warm, this hall was only closed at the house front by a sash-door fastened by an ordinary cast-iron bolt, one inch wide by one eighth of an inch thick. Woods' room was upstairs. Briggs advanced to about the center of the living-room, from where he could command a view of the bed in his wife's room. Some slight noise made by him caused a movement by an occupant of the bed, and Briggs, his suspicions now converted into certainties, raised his pistol and fired. Woods sprang from the bed and the room, turning into the front hall. Briggs fired another shot, and then, changing his position by advancing so as to command the hall, fired again. Woods had by this time reached the sash-door, and not waiting to draw the bolt, he threw himself against the door, breaking the bolt squarely in two, and continued his flight down the slight hill on which the house stood to the nearest cottage, about one quarter of a mile away, where he fell at the door groaning. His fall and groans aroused the inmates, who got up, opened the door, and were considerably surprised to find a man without a stitch of clothing on him lying on their doorstep. Woods was carried into the cottage and put to bed. On the third day he died.

The autopsy disclosed the gunshot wounds. One through the fleshy part of the inside of the right arm, another grazing the right side, about on a level with the wound in the arm. Both of these were clearly made from behind forward, and neither was a dangerous wound. A third wound of entrance, oval in shape, was found in the left chest, in the third intercostal space, penetrating the cavity. On opening the chest the right cavity was found full of blood, right lung compressed to its smallest extent, left lung normal. The track of the ball was clearly marked by a red line, and led to the pericardial sac, into and out of the right auricle, across the lower edge of the right pleural cavity at its internal angle, through the diaphragm into the liver, which it traversed, and was found lying in the fat and areolar tissue near the gall-bladder. Brain and all other organs were healthy, and no cause of death except the pistol wound was found.

The evidences here presented by the wounds alone were most important. The prisoner claimed he had shot Woods as he was in the act of rising from the body of Mrs. Briggs, and as Woods ran down the hall he had fired at him twice. The wounds in the right arm and side were probably these last two shots, they showing clearly the bullets had passed from behind forward. The fatal wound could only have been received in two ways, either as claimed by the prisoner, he standing and Woods nearly horizontal, or from above, the wounded man being erect. Of this there was no evidence, there being no doubt that Briggs entered the room from the window, and that he fired from about its center. The ball nowhere touched bone, was not upset, showed the marks of the "lands and grooves" in the rifling of the barrel, had made a straight line in the body, and gone as far as it had the power. It was of .36-inch caliber, the pistol being a large one. I advised the district attorney that the evidence of the fatal wound substantiated the statement of the prisoner. Briggs was convicted of manslaughter.

Another point is brought to notice by this case. The bullet cut through the heart, and yet, after receiving what would generally be stated as a wound which would be immediately fatal or at least would incapacitate the recipient from any strong muscular effort, the man jumped from the bed, ran down the hall, broke an iron bolt one inch wide by an eighth thick, ran about a quarter of a mile before falling exhausted, and then lived three days with every pulsation of the heart pouring blood out of it. There are plenty of cases on record where instant death did not follow a gunshot wound of the heart, but I do not know of one where after being wounded by such a large bullet the injured person did so much. It leads one to be careful in pronouncing a decided opinion on such a wound as to its being instantly fatal. It certainly is one which in many would be so; but all considerations must be taken into account, as well as the extent and character of the wounding, before definite *ex cathedra* statements are made.

Another death from gunshot injury was that of Mrs. Jesse Billings, who, while sitting sewing opposite a window, was killed by a bullet fired from outside of the house, and which entered her head but did not go out of it. Her husband was arrested for the murder and twice tried, the jury disagreeing in the first and acquitting in the second. The time was the evening of the 5th of June, 1878. She was sitting with her left side toward the window and about three feet from it, the lamp on the table

was burning, and the window-shade was up. As soon as the shot was fired she fell to the floor dead. The autopsy showed that the ball had entered the left side of the head, about half an inch above the opening of the ear, had plowed its way across the base of the skull to the opposite side, where it caused a triangular fracture of the mastoid portion of the right temporal bone, forcing this through the skin so the fragment protruded. The ball stayed in the skull at the base of this triangular fragment, and partly buried in the posterior surface of the right petrous portion. The autopsy was carried no further than the head, but as certain questions concerning the size of the bullet and its action upon the skull came up in the first trial, the body was raised and head removed that more careful examination could be made of it. The case was evidently one of murder, and many questions relating to the killing and in connection with the weapon which the people claimed was the one used were relegated to the medical witnesses. It was claimed by the defense that the ball would have gone through the head if it had been fired from the rifle or carbine the people put in evidence. It was thought some little retarding of the bullet might have been caused by its first going through the window-pane, and another point raised by the defense was that the weapon could not carry unexploded powder a greater distance than one foot, and at this distance the moving body of gases of the discharge would blow the window-glass from its frame: hence this point. Another apparently strange fact was that the hole in the glass through which the bullet had passed was enough smaller than the caliber of the gun (.44 inch) as to prevent an unfired ball going through without breaking off the edge of orifice.

All these questions were acted upon by the medical men engaged on both sides, for the answers had to do with the wound found in the head of Mrs. Billings. The evidence of the wound itself was that a weapon of forceful fire and large caliber had made the injury. The ball, at least so much of it as was found in the head, weighed but 165 gr., while an unfired ball of the cartridge used in the carbine weighed 220 gr., and the recovered bullet was very much upset. From the wound and the ball found it was evident that pistol or rifle had been used, for a smooth bore was out of the question, lines showing the impress of the lands and grooves of the barrel being found upon the bullet. The district attorney wished two questions definitely answered, and these were, What effect would the ball have upon the bone? and, What the bone upon the ball? To decide these it was considered necessary, supposing the carbine to be the weapon, to know what force a ball fired from it would have, for the ball did not go out of the head. The piece was therefore tested at the United States Arsenal at Springfield, Mass., permission to do so having been obtained from the war department. It proved to be a weapon of low velocity, the mean being 998.8 ft. per second. This brought the energy of the ball down to 521.1 foot-pounds, or about half what it would have been had the velocity been up to that of an ordinary rifle, as stated by the defendant's experts to be—about 1300 to 1400 ft. per second. The force of the bullet was not so very much more than a ball fired from an army revolver. And the force being found so much less than was expected, the stopping of the bullet in the head was not such a mystery, especially when the thickness of the skull was taken into account (and it was abnormally thick and dense), and also the course of the ball. Tests were also made at the arsenal to determine whether the bullet, passing

through glass, lost any of its velocity. It was found that no appreciable effect was made by the glass. The ball struck almost its full diameter on the base of the left petrous portion, and crumbled this part of the temporal bone so but little of it could be recognized. The ball, having plowed its way through this bone, passed over to the right petrous portion, into

Fig. 65.

Mrs. Billings' skull. Point of entrance of ball.

Fig. 66.

Mrs. Billings' skull. Hole made by piece of bone being driven outwards backwards.

which it crushed a little, and expended its force in breaking the triangular piece of bone from the mastoid portion, and forcing this outward through the skin and tissues. The effect the ball had upon the bone was to fracture the skull in different directions; but the most noticeable effect was the almost complete disintegration of the left petrous portion. This might be described as being ground up. The bullet seemed to have the effect on it that is produced on the contused tissue when the wound is in the soft parts, and this complete destruction may partly be accounted for by the somewhat brittle character of the petrous portion, it containing hardly any cancellous bone. It yielded, therefore, more readily to a sudden and forceful contusion or concussion, and went all to pieces. Upon the rest of the skull the action of the bullet was what would be expected and is usually seen: lines of fracture radiating from the point of contact and following the general laws of physics.

Fig. 67.

The action of the bone upon the ball was to use up part of its lead. The first impact with the bone did the upsetting, but its having to plow through such fine, sharp particles as the fracture reduced the petrous portion to, caused more loss of substance than would appear reasonable if it could not be shown by other experiments to be probable. We may assume the ball to have been of 220 gr. weight before firing. It was 165 gr. when found in the head. To see what effect might be had upon a bullet following as nearly as possible the track of this one, I made six experiments of shoot-

ing at cadavers, and then examining the heads afterward, care being taken to recover every particle of lead possible. In the last of the series

Fig. 68. Fig. 69.
Sixth shot. Experiments on skulls.

the bullet followed more nearly the track of the Billings ball. The subject was badly decayed, and the skull old and very thin. But the ball struck the base of the left petrous portion fairly, and had but strength enough to fall out of the head, on the right side, upon the table, and then roll to the floor. I give the record of this experiment, as made at the time. Sixth shot, no glass, distance ten feet from subject:

Fig. 70.

Weight of ball.................		220 gr.
Weight of ball recovered ......159.291 gr.		
Weight of lead found ....000.000 "		
Total weight of lead recovered 159.291 gr.		
Loss not found .... 60.709 "		

The other five bullets lost anywhere from 3.975 gr. to 50.557 gr., and by loss I mean total loss, the lead not being found even in small particles. But in none of the first five experiments did the bullet follow the line of the Billings ball, and nowhere do we find an equal amount of weight lost until the experiment quoted where the petrous portion was traversed by the bullet. These experiments then proved that the ball taken from Mrs. Billings' head could have weighed 220 gr. before being fired, and proved further that for such a bullet to lose as much as was the case in the Billings ball, it would have to travel through considerable bone, which would cause enough attrition to reduce its weight.

But these two questions out of the way, and the third one of the gun being of comparatively low force, how could the bullet be for a weapon of .44-inch caliber when the hole through the window-pane would not admit of such a ball passing through it? This was answered by a num-

ber of experiments, firing at glass set in sashes, both glass and sash being similar in size and weight to the window through which the fatal bullet had gone. The notes show for these tests the following: "Ballard carbine, old style, .44-inch caliber, long cartridge, 220 gr. lead, 28 gr. powder. Experiments made May 8th and 10th, 1880, in the Tenth Regiment Armory, Albany, N. Y. Shots fired through glass set in sashes: glass, $28 \times 13\frac{1}{2}$ in., double thick, American make." The distance from muzzle to glass was generally ten feet, but other distances were tried, from seventy feet down to two. At the last distance the glass was blown out of the frame. As a summary the notes state:

Balls unable to pass	1
Balls barely passed	3
Balls passed	18
Cartridges passed	21
Glasses blown out	2
Total	45

From these tests, in forty-five shots one hole in the glass would not permit an unfired ball to go through without further fracture. The force with which a bullet strikes a pane of glass acts precisely as it does on the tissue when it enters or wounds the soft parts of the body. It disintegrates by the concussion the part struck. So in the glass the action is so rapid that the part struck is punched out before it has time to call on the surrounding parts for help. And the glass yields a trifle to the force, resuming its natural position after the momentum has passed on. Again, the temperature of the air and its humidity have something to do with the glass yielding. Another piece of evidence then in the case under discussion was shown to prove that the carbine could have been the weapon.

It was claimed by the defense that the gun could not carry unconsumed powder farther than one or one and a half feet. It should, however, be borne in mind that in fixed ammunition the bullet is driven into the cartridge directly upon the powder, and generally the heel of the ball is greased before being put into the shell. As long as that grease holds on to the ball, just so long may a grain or two of powder cling to it and be carried great distances. As the firing experiments at glass had proved that within the distance of two feet the gases would shatter the glass, it would have been impossible for the carbine to have been the weapon, if it could only carry unburned powder one foot, and powder or marks of powder were found in the window-sash. To determine this question more experiments were made. Seven boards, of about fourteen inches by ten inches, were fired at with the carbine, the distances from the muzzle being from ten feet to two feet. The boards were produced in court, and tests then made of what was supposed to be powder implanted in them. The suspected grains were picked out and put on a piece of glass. A platinum wire-point, heated by a galvano-cautery battery, was brought in contact with the grain on the glass. From eight feet down to two distinct flash and smoke were elicited, showing the grains to be powder. At ten feet no flash could be gotten, but the marks were considered to be those of powder. The experiments were, however, proof that the carbine could have been the weapon, for at eight feet the window-

pane would not have been blown out by the discharge, and the gun could implant unburned powder into boards that far from its muzzle.

The evidence of the wound, therefore, was in support of the proper claim that the carbine shown by the testimony to belong to the prisoner, and which had been hidden in an old well on his farm, could have been and probably was the weapon with which the crime was committed. But as said before, when speaking of the nearness of the muzzle to the gunshot wound found, the fact that it might have been the weapon was only conclusively shown by the various experiments made with it.

In 1881, in Herkimer County, a boy named Klock, of sixteen years of age, shot and killed a man in a barn. The ball entered the chest cavity and caused death by hemorrhage, the pulmonary vein being cut. He was tried for the crime of murder, and set up self-defense as the reason of the killing, claiming the man was about to attack him, when he drew his pistol, stretched his arm to full length, so that the muzzle almost touched his assailant's body, and pulled the trigger. The truth of this story was at first doubted, and the district attorney wished to know how near the muzzle of the pistol had to be in order to scorch the clothes. The pistol was a small one of .22-inch caliber. Tests were made, part of the man's coat and waistcoat being used, and some cotton cloth similar to the shirt worn by him. It was found that the cloth would not singe beyond a distance of two to three inches, but at this distance the cotton would be set on fire. As the waistcoat was singed, it showed that the boy's story of the nearness of the weapon was true, and other evidence in the way of direct proof of the attack by the deceased being produced, the lad was convicted of manslaughter and sentenced for four years. In this case, if tests had been made on other clothes, it might have led to the giving of improper testimony, for the waistcoat was woolen fabric, and it did not take fire so readily as the cotton. To rely on the cotton alone would have been improper.

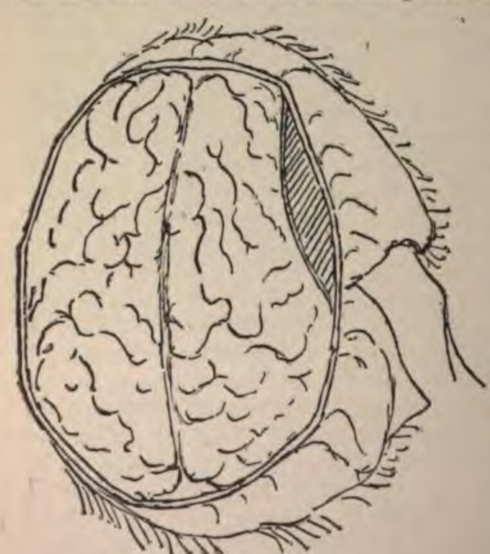


Fig. 71.—Mechanicsville Case.
Blood-clot from right middle meningeal artery effused between bone and dura mater.

In 1880, on Christmas day, I was summoned to Mechanicsville, Saratoga County, to hold an autopsy on the body of a man supposed to have been murdered. External examination showed a badly contused wound over the right temple. No fracture could be detected. On autopsy a fracture was found opposite the contusion, which had allowed the inner table of the skull to cut the middle meningeal artery, and a large clot of blood was effused between the bone and membranes, causing such severe pressure that the brain did not resume its natural form after the clot was

removed. No other mark of violence or other cause of death was found by a full examination. All the organs were healthy. The wound had evidently been made by one blow, and with a rounded sort of weapon. A piece of pine board, five eighths of an inch thick, about ten feet long, and four and a half inches wide, was supposed to be the weapon which had been used. It appeared rather doubtful if one blow from such a weapon could do such an injury, and the absence of laceration did not seem likely with the sharp edges of the board. Still, for want of a better, it might have been the weapon. Examination of the room where the murder was committed showed a low ceiling of not over seven to eight feet. There was evidence to show that the two men had been quarreling and were standing up when the blow was struck. If this evidence was true, force enough could not have been given with the board produced to have resulted in such an injury. Searching brought to light a piece of log, cut so that two limbs, short, led from the trunk, and which had been used as a boot-jack. This was a hickory or ash log, still had the bark on, and was heavy. One arm of the boot-jack made a convenient handle, and with such a weapon it did not need height of ceiling to get full arm-swing so as to deliver a blow that would produce the condition found at the autopsy. I was inclined to look on it as the more probable weapon, but the case never came to trial, the assailant being arrested in Pennsylvania and committing suicide in his cell. The evidence presented by the wound was such as to call for more examination of the scene of the murder than had been made, for while it was homicide from the fact that the quarrel had been heard taking place and the suspected man had fled, the nature of the injury was not compatible with the weapon that was at first supposed to have been the one used.

In May, 1885, a woman was found dead in the yard of the house where she lived, in the village of Fort Edward, lying on her face, and with marks of violence on head and other parts of her body, with evidence of a struggle, from the torn clothing. The autopsy disclosed several severe contusions and some laceration on left side and back of head. Also contusions on arms, and some on trunk. The dress was torn in front. On opening the body, lungs were found to be congested. Heart was fairly healthy, right ventricle empty, left also, but *fluid* blood ran from right auricle into the right ventricle. The stomach gave appearances of free indulgence in alcoholic liquors. The spleen, liver, kidneys, and pancreas were all congested, the blood being dark and fluid. A small ecchymosis was found on some of the small intestines. Brain was congested. Clots were found under the larger contusions in the head, but not fractures. It was stated by the district attorney that the evidence he had showed a drunken fight between the woman and her husband, both being intoxicated, that she was struck with a revolver butt in the hands of the man, and that she was last seen alive walking toward the outhouse in the yard, near which she was found in the morning. Some sand in the nostrils and mouth led to further question. It appeared that she had fallen, as she staggered when walking, and when found her face lay in a sand-heap which was near the outhouse. It rained a little in the night, and the sand was wet as well as her clothing. The husband was under arrest. The autopsy was thirteen hours after death, and rigor mortis was well marked.

While the evidences of the different wounds showed a severe beat-

ing, none of them could be considered mortal or dangerous to life. Even the main contusion over the right temple, which when received knocked her down, was not necessarily a fatal injury. The appearances of the internal organ, however, and the position the body was found in, face downward in the sand, showed death was from asphyxiation, and not from the injuries. The coroner's jury so found, and the man was released.

On March 4, 1879, Mr. W. J. Hadley, a prominent lawyer in Albany, N. Y., was stabbed twice by a man named John Hughes. The trial was held at the Oyer and Terminer in March, 1880, and resulted in a verdict of murder in the second degree. The assault was made in Mr. Hadley's office in the morning, and from there he was removed to his home, where he died from the effects of the wounding late in April. The wounds were described as incised wounds, one penetrating between the bones of the left forearm a little below its center, going completely through, and another in the right side over the short ribs, about two and a half inches to the right of the median line, its direction being downward and backward for about an inch and a half. The wound penetrated about four inches. It had not entered the abdominal cavity. Blood was freely scattered about the office and on the clothing.

The patient was sixty-five years of age. The blow making the stab on the right side was so severe as to separate the cartilage of the seventh rib from the bone, but no displacement took place at first. The prisoner was a one-armed man, and, as is usual in such cases, the one arm having to do the work of two, it was much stronger than had he had the normal number of limbs. The force of the blow, therefore, was greater and without any apparent increase of muscular action to those who saw it struck. The patient was of highly nervous temperament and comparatively little muscular strength. He was a well man, however, not having any organic disease; but the fact of his having been struck down in the way he was, by a client who was demanding money of him, was a nervous shock, from which he at no time recovered. He rallied from the physical shock the night of the assault. Pyæmic abscesses formed on forearm and side, and the autopsy disclosed a circumscribed peritonitis around the liver, the necrosed end of the cartilage having cut through the parietes, and by pressure brought on an ulceration of the liver and the attendant inflammation. Death was caused by exhaustion due to this blood-poisoning from the suppurating wounds.

The evidence of the wounds themselves was that they were made by some sharp instrument, were stab-wounds, and were made with force. The evidence from the autopsy was clear that death had resulted as a sequence of the wounding, for all the organs were found in good condition. The peculiar effect of the patient's mental condition is to be noted in the case. Had such wounds been inflicted on a strong, ordinary man, the chances are they would not have proved fatal and troublesome. Sepsis might certainly follow, as in this case, for the knife-blade could carry septic material with it when making the wounds, and in Mr. Hadley's case very likely did. But even then, if the wounds had been upon one whose mental shock, if such a term may be used, had not been so great, they were not wounds that would be considered more than dangerous. Here, however, the patient never rallied his general mental tone. And nothing could arouse him. He objected to the taking of food, and

in every way was passive. That this was the condition was of course no palliation to the crime. The intent to do injury was shown by the assault, and that the assault proved more severe than was intended by the prisoner was no mitigation of it.

In 1878, in Albany, N. Y., a man named Mallon shot his wife, killing her instantly. The weapon used was an old-style Springfield rifle, one Mallon had carried in the war, and it was loaded with buckshot and slugs. The shooting was in a narrow hall of the home they lived in, and the walls and ceiling were marked with blood and tissue, which the near discharge of the gun had blown over them. A door behind Mrs. Mallon was pierced in several places by the missiles that went by her. Mallon was indicted for murder, but a miscarriage of justice brought in a verdict of manslaughter in the third degree.

I did not see the wounds, and therefore in that particular can only speak from hearsay, for the records of the autopsy were destroyed by a fire which burned the city hall. The majority of the wounds were in the chest on the right side, some, however, penetrating the abdomen, and the right arm and forearm also suffered severely. While, on account of the loss of the records, the full evidence to be drawn from the wounds cannot be commented on, the evidence as to the position of the woman when shot was clearly shown by the manner in which blood and tissue were thrown on the surrounding walls. The defense claimed, and, by the verdict of the jury, apparently established, that the gun was accidentally discharged, and the wounding was from the front of the hall and not the back. But if this was the fact, then it was hard to explain why all the blood-stains on the wall were evidently and absolutely in the opposite direction. As will be referred to later on, the manner in which blood strikes a wall is indicative of the directing force. And in the same manner, if tissue is by a tearing discharge thrown on a wall or any other surface, the mark it makes is a slight guide to the direction it came from. It is a positive rule in the giving of evidence that the medical witness exhaust every means to assure himself that but one statement can be made about any given condition he has to pass upon. It has already been said, as a caution to medical witnesses, that it is the better part when giving testimony not to be too minute, but to—having the fullest of notes and examinations—condense many things into one general statement. The part I played in this trial emphasizes this advice, and is here given for that object. A piece of ceiling-plaster, without paper on it, but having in its center a dark, dried, and blackish-appearing lump, was brought me from the district attorney with the request that I would tell him what the black stuff was. The officer's directions were to say nothing further. Sections being made, the microscope disclosed the fact that this dried mass was human, voluntary muscle. But as a man was on trial for his life, and the specimen was shriveled beyond any possible recognition, except by microscopic examination, I made further tests, taking at the market specimens of beef, mutton, and pork, and from the dissecting-room voluntary and involuntary muscular fibers from old and fresh subjects. The result of all examination was the positive conclusion that the specimen could be nothing else than a piece of voluntary muscle from a human being. Reporting the results of the examinations to the district attorney, he asked that I state them to the jury, in "plain English." This was done. After the verdict was rendered—and if the evi-

dence of this piece of tissue and of other blood-stains was correct, the woman could not have been where the defense claimed she was—the prosecuting officer asked one of the jurymen how he came to render such a verdict; did he not believe the evidence of the doctor? The reply was made: "Wall, if that 'ere fellow had a-knowed what he was about he wouldn't have taken so durned much trouble!" It was a lesson to me that the ordinary juryman does not appreciate the reason why every test is made, but only looks at the general result.

Where the assault is with a cutting weapon, and vessels are severed so that spurting follows, there is chance blood will be found upon the clothes of the assailant. That blood is not found, however, may be no proof that the prisoner is not guilty of the crime, for the cutting may be so done that no blood will get upon his clothes or person. A notable instance of this is related by Dr. Taylor in the murder of Lord Russell, where his throat was cut by his valet, who wore no clothing when committing the murder. Or the throat, or wound, whatever it may be, may be cut or made from behind, and in that way the evidence of blood upon the clothes of the assassin may be wanting. In the murder of Catherine Dunsback by Latrimouille, in Albany County, in 1878, the murder was by throat-cutting. It was expected the clothing of the prisoner would show marks of blood, as the cutting was done partly in front of the woman, but no blood-stains were anywhere traceable. The murderer wore his hat at the time of the assault. The hat, coat, waistcoat, and trousers were all carefully examined, but no blood found anywhere. It transpired later in the case that the prisoner had worn at the time of the crime a long gray ulster. What became of it no one knows, for it was not in his possession at the time of his arrest, and no trace of it could be discovered. This would lead to the logical assumption that this ulster had blood on it, and the prisoner had destroyed it to remove the evidence it might give. On other testimony presented, a verdict of guilty was rendered, and the man executed.

Evidence to be drawn from Blood-stains. (Also consult Blood and Other Stains.)—A medical examiner should not only see and note all marks upon a body he is called upon to inspect, but he should, where possible, investigate the place and its surroundings where the suspected crime had been committed. And the clothing worn by the prisoner at the time of the assault, and any other clothes he may have, should be carefully looked over for the evidence of stains from blood. Blood, when thrown from a vessel, if it strikes a wall or furniture at an acute angle, gives such a mark that strong inference may be drawn as to the direction it came from. Being globular in form while in flight, its first marking is a round splash indicative of the size of the globule; and this round splash tails off into a point given by the force carrying the elongated globule as far on the surface it impinges against as circumstances will permit. Specific gravity plays its part in the formation of the characteristic mark. The stains point downward, according to the point of the parabola they have reached at the time of their contact with the wall or furniture. This gives an idea as to the distance they may have come from, the size of the spurting artery being known. The tail of the splash is generally the darkest, gravity having carried the major portion of the blood there, and consequently the rounded or upper part of the mark is lighter in color than the pointed portion or final ending.

The manner in which blood flows from a wound should also be noticed. As a general rule the greatest amount of blood will be seen near to the wounds themselves, especially if the patient has lain quiet after the wounding. It should be remembered, however, that persons dying from hemorrhage become very restless, move about, or try to do so, unless the wound is such that motion is prevented by the rapidity with which life is lost. Consequently the largest spot of blood may be at a distance from the body, and be only indicative of where the wounding first took place. In November, 1870, a man cut his throat in a hotel in Burlington, Vt. The fact was discovered about nine o'clock in the morning. Happening to be in the house and hearing the alarm, I went up to the room and noted the following: The man, still alive, lay on the floor about four feet from the window of the room and about eight feet from the door. Between him and the door there was a pool of blood about the size of an ordinary saucer. Another clot was under his neck, not so large as the first. Two more, one longer than the first named, were between the body and the window. By the window was a rocking-chair, and in front of it a tin pail, about in the position one would place it if it were set between the legs of one sitting in the chair. Blood was in the pail, all over it, and on the carpet. Here, evidently, the greatest amount of blood was lost, and here the suicide had cut his throat, intending to bleed quietly into the pail; but nature was not to be denied, and he moved about, bleeding a while here and there until he fell exhausted. All hemorrhage had ceased when he was found. In the slop-pail was found the razor with which the wound was inflicted. These points having been rapidly noted, the man was put on the bed and the wound examined. The cut was not deep, did not involve either carotid, was between the cricoid and thyroid cartilages, and the only vessel that could be found severed was the cricoid-thyroid artery. How such an amount of blood could have come from this small vessel seemed a mystery, but there was no other wound, and no other place from which the blood could have come. Death resulted in the evening, the man not rallying from the shock and loss of blood. Blood was on his right hand and some on the left. The clothes were bloody in different places, noticeably in front, and it was concluded that the other blood-stains were probably gotten when he fell and tried to get up, falling and rolling over, until he lay quiet in the position he was found in.

The evidence of the blood-stains in the Budge case, before quoted, were very marked. From the large wound, cutting all the great vessels of the neck, blood only flowed down by gravity on both sides of the neck into the feather-bed underneath. A few sprinkles of blood were on the right sleeve of the night-dress, a little blood on the right hand, a few spots on the sheet, and bloody marks on the pillow next the one on which the woman's head lay. In all only about one quart of blood had been lost. It was found that great effort was made to stop the flowing of the blood, the doctor stuffing the wound with cotton, and even then persistent oozing was noticed. And this after the body had been dead for twenty-four hours. With no more blood on surrounding objects from such a wound as this, the proof is positive that the heart had stopped its action when the cut was made. Where execution is by decapitation, the records show that a tremendous spurt of blood follows the falling head; it springs from the body like a jet from a hose-pipe; and after that the

bleeding stops. The want of more blood on the front of the body, on the hands, the night-dress, the bedclothes, the walls, the floor, everywhere, in short, that the action of the heart could throw it, negatives the claim of the defense in this trial that the wound was suicidal.

I was called one day from my carriage to see a woman who had cut her throat. She did it in an outhouse, and used an ordinary table-knife, which she sharpened by whetting on the back steps of the house, these steps being of stone. When I saw the body it was in a heap on the floor. Blood was everywhere—walls, seat, floor, dress, right arm and hand. The cut had severed the left carotid. Two cuts were made: the first, superficial, going but barely deeper than the skin and crossing on the left cornu of the hyoid bone; the second, lower, cutting part way into the trachea. This last took the vessel in its course, and was carried no further.

The manner in which the blood flows from the wound may be indicative of the position of the assailed at the time of the wounding. If the blood is down the front of the body from a cut in the throat or a stab of the chest, the probabilities point to the erect position; while if it is toward the sides of the neck or runs to the arm-pits, the assumption would be that the wounds were inflicted when the body was recumbent. In the case cited of the man who was hit with a brick, and the temporal artery of the right side cut, the bleeding after the first spurting of the vessel was over the face and chest, it running down upon the shirt. In October, 1893, a gentleman was injured by his horse falling at a fence while following hounds. One of the injuries received was a cut underneath the chin. The cut was caused by the chin being suddenly and violently driven upon his collar, which happened to be stiffly starched. Although rendered insensible by the fall, he was instantly picked up by companions, and regained consciousness as soon as he was on his feet; the blood from the wound had, before hemorrhage ceased, covered his shirt-front, was liberally sprinkled on coat, waistcoat, and breeches. From the blood-stains on the clothing alone, the evidence would be properly drawn that the person bleeding was in the erect position, for the wound could not possibly have sent the blood where it was found had the man remained on his back.

The stains made by blood upon clothing can sometimes be made out, or rather surmised, long after they have been received. To tell when they have been made is an impossibility if the marks have become perfectly dry. A year or more after having in an operation got some blood on a pair of trousers, the stain remained, although it had been carefully washed. It was a peculiar brownish color, but whether made by blood or not, one not conversant with it in the first instance could not state positively. It had a suspicious look, as if it might have been from blood, but that is all that could be said. On linen or cotton, the stuff not being colored, a fresh blood-stain gives a red color, which soon, however, changes to brown; and after such change, and perfect dryness is present, the time when it was made cannot be placed, for but little further change takes place. The dry blood-stain is hard, giving the cloth the feeling of being starched or gummed in that particular spot; and if freshly dry, there is a glaze over the spot. If no attempt has been made at washing, and the stained part be rubbed together, a brownish powder is produced, which, placed under the microscope, moistened with water or glycerine,

will show blood-corpuscles. That the stain then is blood may be confidently stated, but that it is human blood is another affair. While it is perfectly well known that the human blood-corpuscle has a certain average measurement, and differs from all other animals to a slight degree in that measurement, it is equally well known that when the blood on clothing or anything else has had time to become perfectly dry, a shrinking of the corpuscles takes place, and although when treated with water or glycerine they resume some of their natural shape, still it is a mooted question whether an expert can swear positively a given blood-stain was produced by blood from a human being, and from no other animal. The medical witness can say it is blood and blood alone which made the staining, but that is as far as it is considered safe to go. Other evidence should be brought to show that there was no other source from which the stains could come than the wounds proving mortal to the *corpus delicti*, and as the medical witness says confidently the spots were made by blood, the corroborative evidence proves the blood to be human, and from the wounds found. In addition to this examination chemical tests should be used, and no means left untried to prove conclusively that blood alone was the agent making the discolorations.

Blood upon Weapons.—The evidence that a knife which is clean of blade has been lately used in the cutting of tissue where blood would get upon it, is not difficult to deduce from the stains on the blade, even if but very little blood had marked the steel. If, however, the knife be old and the blade rusty, the task of deciding as to the marks found having been produced by blood or some chemical action upon the metal becomes one of delicacy, and requires more examination than mere visual inspection. The rusting caused by the juice of lemons is at first sight apt to be taken for blood, and so close is the resemblance that chemical tests have to be resorted to to decide the question. Stains upon the blade of the weapon are not always the only spots that may be found, and every particle of the weapon should be carefully searched and tested before stating no blood is on it. Where a fixed handle is present, if it is made by two pieces of wood, bone, or other substances being riveted to an extension of the blade, the rivets should be drawn, and every particle of dust or foreign substance found be examined in all the ways known for testing for blood. The same where the knife is a clasp-knife. Blood may have been plentifully spread over the blade, and the knife carefully washed by the criminal, and still blood be found in the cracks under the handle pieces in the hinges, and prove an important link in the chain of evidence. Fire-arms are not so apt to be marked by blood. They may be used, however, in clubbing, where the noise of the discharge would be liable to bring about discovery. The same condition may then be found as is noticed where blunt weapons are used, and the blows struck cause more or less bleeding. When the weapon is wood, the blood makes its mark readily, and can be studied in the same way as blood upon cutting instruments. If the bark is still on the club used, then blood will be found clotted in the interstices of the bark, and may be more readily detected. The weapon may be a stone, and blood be found upon it. In the trial of Sam Steenbergh, a negro, for the murder of one Palmer, at Fonda, N. Y., the murder was proved to have been committed by Steenbergh pounding Palmer on the head with a stone, even after the body was upon the ground. The skull was crushed and the scalp broken.

A stone having blood upon it was found by the body and was the weapon used, the wounds being of such a nature as could be made by a stone of like character. It was, of course, but one part of the evidence, but it filled out the perfect line of the people's case. The verdict of guilty was rendered, and the negro hung.

When hair is found clinging to a weapon it may become a factor. The microscope will determine what kind of hair it is, and it may also, according to Casper, decide whether it has been cut, or broken by a blow. Wool and cotton fibers found adhering to a blood-stained weapon may have the appearance of hair, but the magnifying-glass proves the character and shows wherein they differ from human or animal hair. Taylor calls attention to an interesting case where rabbit-fur and shellac were found on a rake, which had evidently got on the rake by the burning of a hat in which this fur entered as one of the constituents. It is considered, then, that the clinging of hair to a weapon may aid in proving it the one used in the assault; but before the medical witness can state positively the hair is that of the deceased, he must make comparisons with other hairs taken from the victim, to see if the two correspond; for the hairs of different persons vary in size, the characteristics of the markings alone being the same.

Bullets, Shot, and other Substances in Wounds.—Where the homicide has been by gunshot injury, portions of the dress or sometimes of the wadding of the gun may be found in the wound. Nowadays it is rather rare to find muzzle-loading guns in which paper or other substances may be used for wads. The breech-loader having almost universally taken the place of the muzzle-loading fire-arm, the wads for the cartridges are of so little cost that one rarely finds anything else than the machine-made ones used, and consequently if one of these be found in a wound, it merely confirms the evidence of the wound itself as to the character of the gun. It may be found entire, or enough so to give the caliber of the weapon; but direct evidence as to the wad having been part of some paper or letter belonging to the suspected assassin is in these days rare to find.

The shot taken from the wound may have some bearing, if other cartridges are found to belong to the prisoner loaded with the same kind and size of shot, but while all shot that can be found in the wound should be kept, the chances that they can be proved to have belonged to the prisoner is remote. The Billings trial showed the importance of recovering by patient search all the lead possible from a gunshot wound where bone has been traversed by the ball. The ball recovered is also of value. If it can be measured, either by calculating the lands and grooves found upon it or by some portion which still maintains its periphery undisturbed, it may be stated as positively of a kind able to be fired from the weapon suspected, or that it could not be; and this fact alone may free a person accused of crime. In a brawl in Troy some few years ago, shortly after the second trial of Jesse Billings, a man was shot. More than one shot was fired, and by different persons. One arrested for doing the wounding was freed, by the medical witnesses who had held the autopsy proving absolutely that the ball recovered from the dead man could not have been fired from the pistol known to have been in the possession of the prisoner at the time of the brawl, and which was taken from him on his arrest. Had the doctors not saved and produced the

ball, the man would probably have stood a fair chance of being convicted of homicide; for the testimony presented pointed strongly to him as the one giving the fatal shot. In the case of Woods shot by Briggs, the ball was recovered entire. It was not upset, as it had encountered nothing but soft parts, and it was the same caliber and the lands and grooves were of the same number and size as those in the pistol used by Briggs. This was further proof of the story of the prisoner, he relating he shot Woods with a certain weapon.

Dirt, grass, hay, and similar substances may be found in wounds, and should all be carefully preserved, as they may aid in tracing a crime to the person guilty of it.

Position of Weapon, Clothes, or Body.—Where death is homicidal, suicidal, or accidental, the position of the weapon to the body has a bearing on the decision of the examiner in determining to which category the death belongs. If a weapon is found near to a body it may argue strongly for suicide; but suicides have been known to endeavor to simulate homicide, and throw the weapon some distance to lend color to this view, and in the same way criminals have placed weapons by their victims in order to cover the crime. The manner in which the wound is made, and the way the weapon is found with reference to the body, taken together, are strong points on which to reason. In the Budge case the razor with which the woman was claimed to have cut her throat was found lying under the right arm and was partly closed. The arm itself was bent across the chest. There was hardly any blood upon the razor. Taking into consideration the character of the wound in this woman's neck, it is more than questionable if she could have, after its infliction, moved her arm to where it was seen, having first half shut the razor and put it on the bedclothes beside her. To do this is to assume that death was not instantaneous from such a terrible wound, and that consciousness and power of movement existed after both carotids, both jugulars, both pneumogastrics, trachea, and œsophagus had been completely severed. When a knife or razor is found shut after a mortal wound, it is a suspicious circumstance, for one having determined on suicide and inflicted a fatal injury does not care much what becomes of the weapon. Again, where the wound is instantly fatal and made under the pressure of excitement most suicides experience when taking their lives, the weapon is very apt to be found grasped firmly in the hand. This, of itself, would be almost certain proof of suicide, for cadaveric spasm will not take place except at the moment of death, and a murderer does not stay by his prey and hold the weapon in the dead man's hand until it is fastened there by the rigor mortis. In the case of the woman who cut her throat in an outhouse, before quoted, the knife was found in a large clot of blood, and under the body. It had evidently fallen from the hand, and she shortly followed it to the floor.

The position the clothes of the deceased or the bed-coverings are found in should be noticed. In the Budge case the night-dress was open in front, the sheets and coverings neatly folded down upon the bed, and everything about the bed arranged as if the person were merely asleep. It would appear impossible to have this condition prevail if the wound had been self-inflicted; the mere moving of the arm up and exerting the strength necessary to do the cutting would in all probability disturb the neatly smoothed sheet lying folded over the chest.

[illegible] photographs [illegible]

[illegible] the stairway [illegible]

[illegible] was a [illegible]

[illegible] The [illegible] was [illegible]

[illegible] on the side [illegible]

[illegible] in the [illegible] time of [illegible] One [illegible] the [illegible] in the evening. It [illegible] Sunday [illegible] went [illegible] could [illegible] tried. [illegible] a [illegible] the door [illegible] lay [illegible] carefully [illegible] lacerated [illegible] being [illegible] near the [illegible] downward. [illegible] a [illegible] on edge. [illegible] stair wall. [illegible] was also [illegible] following [illegible] was on the [illegible] found on [illegible] were [illegible] of the [illegible] alongside each [illegible]

[illegible] Suicide was out of [illegible] it was presumed he

was so when he died. The autopsy showed the wound on the head corresponded to a depressed triangular fracture of the same shape and dimensions, and death was due to the blow and compression. No other cause for death was anywhere apparent. Rumor had it that Thompson had been on bad terms with the man who last worked for him, and that this man had threatened vengeance. The coroner's jury could not find sufficient evidence on which a warrant could be issued, and so gave the verdict of death from compression due to a fracture received in some manner unknown.

Minute inspection of the photographer's shop failed to show any signs of a struggle. On the wall of the stairway, underneath where the picture had been torn off, were some marks, which examination proved to be made by boot-blacking. They were made from above down, trending in the same plane as the stairs. A hammer, the hammer head square with cut-off corners, was found upstairs. This could have made the wound, but there was no blood or hair on it, and if it had been used it was put back on the bench in the small workroom. There was no mark on the newel-post, stairs, stair-rail, base-board, or floor which would indicate that the head had been wounded by striking against them. And the body lay out straight on its back, one hand across the chest, the other by its side, the clothes not disarranged, and the trousers pulled down on the boots. If this was a fall, and consequently accidental death, how the body could fall from about half-way up the stairs, as it must have to make the boot-marks on the wall or to pull down the picture, strike the newel-post on the left side of the head—for that was the most likely object about which could possibly make such a wound—and then turn over and assume the position this body was in, is hardly possible to imagine. The more probable theory of homicide is easier of explanation. The man, going upstairs, sees an enemy above, coming toward him. He has no weapon, and seizes the first thing he can lay hand to, the picture, turns with it in his hand to reach the floor below, and receives the blow; falls head foremost, feet striking the wall. The assailant follows, and to clear his own way throws the legs over. This turns the body on its back, and to make it appear as if accidental, he straightens the legs by pulling on the trousers. Escape was easy out of the half window into the alley, and from there to the street. This could be conjectured to be somewhat the manner of the death; but so much would have to be mere conjecture that an almost equally plausible theory could be as well constructed on the question of accidental death. The case is one of interest, and will always remain one of doubt. It shows, however, how every point must be taken into account, and how the logical bearing of one upon the other must be carefully studied before a medical witness can pronounce whether death was from homicide, suicide, or due to accident.

When More than One Wound is Present.—The medical witness may be called on to say, where several wounds have been found on a body, which was the first inflicted. Lawyers, apparently, seem to believe that a doctor should be able to state with positive and unqualified specification any question that may enter their heads to ask about an injury, a disease, or the permanent effects of either. Unfortunately for this, man is not machine-made, and what will in one person cause death immediately will in another allow of more or less action before loss of either mental or muscular activity. Therefore it is that a medical witness

oftentimes appears at great disadvantage. He must, however, expect the question, and prepare himself, as well as may be possible, to answer. When several wounds are present, if a case of homicide, or no evidence of struggle is attendant, the mortal wound was probably the one first inflicted; for if the others are such as would not be mortal or incapacitate the assailed from an effort for life, it is a fair assumption that some defense would have been made and evidence of this be found. If the wounds are made by two or more attacking at the same time, no definite answer can be given as to which would be the first, or, if more than one be mortal, which caused the death. The examiner studies each wound on its merits, and by the character of the injury arrives at a probable conclusion of the ones made before and those made after death. Further than this he cannot go, unless other evidence than that of the wounds themselves can be presented which will decide the question. Where wounds are incompatible with one cause for all, the examiner can state with positiveness the ones produced by one kind of injury and those produced by another. This may be most important evidence, for the death may be due to a fall, and the cause of the fall a blow which showed laceration or other symptoms, and the two injuries so placed that both could not be produced by the fall or by the blow.

Suicides often make more than one wound, or may make an incised wound and then use a pistol, or jump into water or from a height. They may do all these, and both cut and gunshot would have been mortal if a little patience to see the effect of their work had been exercised. The finding of a body with its throat cut and with a pistol-shot in the brain would be apt to raise the cry of murder, but calm study of the matter would prove both injuries compatible with self-destruction, although both were mortal. The case of Weston is one where three mortal wounds were present, if not a fourth. Two bullets in the brain, which had traversed it from before backward, one through the heart, and the throat extensively cut, gives a case where the question of which wound was made first is not possible of answer. The surgeon thought, from the amount of blood effused in the chest, that the heart wound was made while the man was living; but it may have instantly preceded the bullet in the brain and before pulsation had ceased, and then the amount of blood would have been equal to that found. The amount of blood found on the clothing and on bushes and grass around where the body lay was not enough to say the throat was cut during life; but as between the two mortal wounds in head and heart, it would be impossible to do more than to give an opinion of priority based on conjecture.

Criminals sometimes make wounds upon themselves as evidence of attack, and that their action was, therefore, in self-defense. The manner in which the wounds are stated to have been received, when compared with the reading of the cut itself, do not always agree, and suspicion is created as to the truthfulness of the prisoner's statement. The marks of the cutting through the clothing will have important bearing in deciding how such wounds have been received, for few care to boldly cut direct through all that may interpose between knife and skin, but rather prefer to see what and how deep they are cutting and then make the necessary incisions in the clothes afterward. As few know, there are points of difference in the beginning or ending of a cut, or that to an experienced eye every wound tells a story; the cutting on the person may

be made in one direction, and the required rents in the clothes in the opposite. In June, 1874, I examined a man named Bruin in the Washington County jail at Sandy Hill, by direction of the district attorney. Bruin was an old man over fifty years of age, but of an extremely bad temper. He was under arrest for attacking with a pitchfork a man who worked for him and inflicting a stab-wound in the face, seriously wounding one eye. The prisoner claimed it was done in self-defense, saying the man had attacked him with a large-bladed jack-knife and cut him in the abdomen. Examination showed a freshly healed wound, it appearing from the cicatrix as if two incisions had been made close to each other, of one half-inch in length, running perpendicularly and situated six inches above the antero-superior spinous process of the ilium, and five inches from the umbilicus, its upper end being at lower border of the cartilage of the ribs. The cicatrix showed the wound to have been made from a cut directed upward, and that it did not penetrate, merely entering through the true skin. Examination of the shirt, waistcoat, and trousers which the prisoner had on, and which he said he had worn when assaulted, discovered rents or cuts in each; but in the shirt there was a tear five to six inches long; in the waistcoat a rent, also several inches long, about on a line with the wound, but extending both above and below it; while the cut in the trousers was so made that when they were drawn up upon the body as far as the make of the garment would allow, the upper edge of the rent did not come opposite the wound. The shirt appeared more torn than cut; the waistcoat was cut from without in and from below up, as if held out from the body and the knife passed through, and then sawed up and down as far as thought necessary; while the cut in the trousers was made by thrusting the knife from within and cutting down. The linings of these two garments told the direction of the cut, while the fibers of the cloth showed in which direction the knife had gone through them. As the prisoner claimed all cuts in his clothing as well as that on his abdomen had been made when he was struck by his man's knife, there was no hesitancy in reporting to the district attorney that the injury was self-inflicted.

In a recent trial in Albany for murder, a strong point for the defense was made of the fact that the prisoner had shot himself immediately after the murder, and had intended to kill himself. The case was wife-murder. A young man named Shattuck shot his wife and then fired the pistol at himself, making a dangerous wound in the right temple; but the weapon was so held the ball plowed the muscles, merely grazing the bone. On the ground of insanity a verdict of murder in the second degree was rendered, and the prisoner escaped the electric chair. From all the evidence of the crime, it was fairly considered his shooting himself was accidental, although the appearance of the scar was well used by the defense. Had the case happened differently, this wound would have been excellent evidence of injury by another, for the pistol was not near enough for the discharge to cause burning by the flash.

Suicide.—To say that all who take their own lives are laboring under a temporary aberration of mind is, in many cases, to rely merely on the fact of self-destruction for evidence of mental unsoundness. That mania is undoubtedly a frequent cause of suicide nobody would deny, and with that class of cases we have little to do, insanity being treated of elsewhere.

It may be said that where insanity plays a part the methods used are at times so peculiar as to lead not only to positive proof of self-slaughter, but to the presence of mental disease. A rational being who decides on suicide does it generally in the easiest and quickest way he can. A plunge in the water, and all is over. Determination to succeed is often manifested. A case occurred of a patient who had been in my wards when I served in the Brooklyn City Hospital in 1870. The man had been operated on for partial removal of the lower jaw. Unfortunately, the surgeon attempted to save the rami, the disease being only in the anterior portion of the body of the bone; but the pterygoid muscles drew the rami inward, causing the remaining parts of the body to press upon the tongue. This being unbearable, a second operation was decided upon, but the patient thought he had had enough. Obtaining leave of absence, he did not return, and the reason for this was explained when his body was found in Gowanus Bay, near the city, when the tide went out, with the pockets of his coat filled with stones. This man was not crazy. He simply determined to die, and took precautions to prevent any effort on his part floating his body after he once threw himself into the water. And then his method insured his body being found, for he was securely anchored in the mud.

As has been seen from the foregoing, homicide may be made to appear like suicide to hide crime. It is rare that suicides so plan their exit as to show a desire to have their death appear to be murder. An interesting case of this character is reported by Dr. J. B. Lewis in his book of "Stratagems and Conspiracies to Defraud Life Insurance Companies." Captain Colvocoresses, a retired officer of the United States Navy, was found in a dying condition in a by-street in Bridgeport, Conn., at a late hour of the night of June 3, 1872. The captain, although possessed of small means, obtained insurance upon his life for $195,000. He was ostensibly on his way to New York from his home in Litchfield when his death took place in Bridgeport. He had been to the boat, secured a room, left in it his traveling-bag, but as the boat did not leave until eleven o'clock at night he left it to go to a hotel and get some supper. When going off the boat he was seen to carry a small black bag and his cane. This latter was a bamboo sword-cane. After getting something to eat at a restaurant, he idled away his time until half-past ten, when he left a drug-store, where he had made some small purchases of paper and envelopes, and being directed how to find the boat, he apparently started to reach it. Just as the boat was putting out the report of a pistol was heard, and a policeman, of whom the captain had earlier in the evening asked some questions, hearing the shot, ran to the place from where the sound seemingly came. Lying on the sidewalk, and in a dying condition, was Captain Colvocoresses. A large gunshot wound was in the left breast, his left hand pressed against it, and he was on his back. The discharge had set fire to his shirt, and the light from it guided the policeman. In a diagonal direction across the street, in the gutter, was an old-fashioned percussion-lock horse-pistol. This weapon had evidently just been discharged. The sword-cane was about two yards from the captain's feet, and toward the gutter. The cane was broken, and the blade in it bent. From examination it had the appearance of having been broken by being struck or snapped over a fence. The bullet had gone completely through the body.

First one thing and then another was brought to light. A pill-box, having percussion-caps which fitted the pistol, was discovered. A boy, seeing a bit of rag sticking out from under a gutter plank, carelessly pulled it out, and with it an old powder-horn. Tiring of his plaything, he threw it where it was afterward found. The black bag carried off the boat by the captain was found on another wharf, partly hidden under a railroad-tie. One end was slit open, and nothing was in it but a blank check-book and some few grains of powder, which, on comparison with the grains in the powder-horn, were shown to be similar. Peculiar indentations were noticed in the bag, and trying the pistol, these were seen to correspond to the point where the hammer would rest if the pistol was put into the bag. The captain's coat and waistcoat were unbuttoned and lay open when he was found on the sidewalk. It was proved that he habitually wore his coat buttoned up, and while it was supposed that the opened clothing was a sign of violence on the part of footpads, the buttons were not torn off either garment.

The evidence of the wound was that of close fire. The discharge must have been fairly near, or the shirt would not have been set in a blaze. And the carefully cut satchel, the peculiar weapon—one which was traced as having been owned by the deceased—the peculiar manner in which the sword-cane was broken, the evident care with which the percussion-caps and powder-horn had been hidden, the repeated questions by the captain in the early evening of the way to the boat, although he was well acquainted with the town, the motive for death, that his family would be left in affluent circumstances, the peculiar manner of his bidding good-by to the family when leaving home that morning—all brought the positive conclusion that this was a case of suicide and not of homicide.

Dr. Lewis, in his report, says the pistol being found thirty feet away was accounted for by the recoil of the weapon, the pistol springing back from the chest after it was fired. I am inclined to differ from this view, and would rather think it an act of volition. All the evidence points to so carefully conceived a plan that some arrangement must have been thought of by which the weapon would be found a distance from the body. Therefore, I do not think it incompatible with the wounding that the captain could throw the weapon. The recoil may have helped in this, the arm giving the sudden jerk predetermined on, and both forces combined carrying the pistol thirty feet. The case of Woods shows coördinate muscular ability after a terrible wound, and in this case but much less was attempted. And the captain was not dead when found, although life lasted but a few minutes after. (Also see article Life Insurance.)

A young man some five years ago attempted his life by shooting. The weapon, a pistol, fortunately for him, was faulty in action, and while the shot was well aimed and intended, it did no material harm. The wound was in the right temple, just in front of the hair line. When I saw the patient, about an hour after the shooting, he was lying on his bed, his head done up in a wet cloth, and he thought himself wounded unto death. As this was what he wanted when he fired the shot, he was perfectly resigned, and did not wish anything done to interfere with an edifying end. But being persuaded to allow an examination of the wound, as soon as he was assured it was but a trifle and there was absolutely no danger, his tune changed, and he was as anxious to live as a few minutes before he had been to die. The wound was a ragged, lacer-

ated one, and but for the powder-marks, not such as would at first sight appear to have been made by a pistol ball. But part of the ball was there in plain sight in the wound, and lying flattened against the bone. Taking this out, it was seen to be only half a ball, so the pistol was produced and the cause of his escape from death was easily explained. The cylinder did not revolve properly, so but half of the chamber was presented to the barrel when the trigger was pulled. The ball cut itself in two, one part going out of the muzzle with just sufficient force to cut the skin, the other half squeezing sideways between cylinder and barrel, and being found on the floor.

When the suicide is by cutting, blood is generally found on the hand using the knife; and if cadaveric spasm keeps the weapon in the hand, the blood is on the back and between the fingers. It is hardly within the range of the possible that a person can cut his throat, severing the carotid, and not have blood over hand and arm. To find otherwise would be to raise strong suspicions of homicide. If the death is by stabbing, then no blood would be expected other than what might flow from the wound on the surrounding parts. The hands, however, would probably be free from stains, and if the suicide threw away the weapon the appearances of homicide would be very real. Other facts would have to be relied on to decide the question, for the evidence of the wound would only show that it could have been produced by the dead as easily as by another.

It often happens that a person trying to commit suicide fails by reason of pointing the weapon improperly. A young man, whose "course of true love" did not run as smoothly as he thought it should, and considering life was no longer worth living, fired a shot at his head from a small pistol, which he hoped would end his troubles. The intention was evidently to fire a bullet into the right ear. Instead, the ball was fired a little to the front and just underneath the zygoma, and as the direction, given by the manner the pistol was held, was upward and forward, the ball passed into the zygomatic fossa, entered and crossed the right orbit, lodging against the nose at the inner canthus. It did not enter the brain cavity, and although a painful wound, was not dangerous. The result was to cure the young man of the desire for self-destruction, and to allow him for the future to observe matters with a "single eye," for the sight of the right was destroyed by the bullet. I removed the ball without difficulty, and the case made a good recovery.

The determination between suicide and accidental wounding is at times difficult, and, it may be said, sometimes impossible; for so many accidental deaths occur when persons are examining or cleaning fire-arms that it is beyond mortal power to say whether the death was by mishap or design. The medical witness can only state the evidences presented by the wounds and weapon, and must use caution in giving positive opinions as to how the death came about. Such peculiar accidents do take place that the range of possibilities for them is infinite, and at times the most improbable happens. Taylor relates a case of where a man's gun went off accidentally, the recoil throwing the gun backward, and as it fell the second barrel was fired, the charge entering its owner's thigh. This case is sufficiently unique to call attention and emphasize the care that must be exercised in the examination of wounds and the expression of opinion as to how they were caused.

Plate VII.

EFFECTS OF VITRIOL.

Burns and Scalds.—While it is not common to consider injuries arising from the application of external heat to the body as wounds, under the definition of wounds before given, and for the purposes of a clearness of description before a jury, the lesions caused by burns and scalds will be considered in the same light as incised, contused, gunshot, or other injuries—viz., as wounds. Burns are considered as those wounds made by fire, heated metals, solids or fluids; and scalds, as the result of hot fluid, like water, tea, etc., and steam. Boiling oil makes a burn as does boiling sugar, while they may also give scalding, if but a small amount of the liquid be thrown upon the body, not sufficient in quantity to cause a true burn.

The danger from either kind of wounding is due to the extent of surface involved or the severity as to the destruction of tissue. A scald or burn which covers a large extent of surface, even though it involve the cuticle alone, is very dangerous to life, for the shock is so severe that the patient may not rally, and death be due to it. In such a case as this pain is excruciating, and aids the shock by its exhausting effect. It is well to remember that such an injury has, especially in children, a stupefying action, and the patient usually dies in a comatose condition. The administration of narcotics may become a question of investigation, as the death may be attributed to their improper use. While pain is a symptom where the burns are slight, it decreases in amount as the severity or depth of the burn and destruction of tissue increases. Where the skin is killed by the action of whatever causes the burn, there is no sensation in it itself, and it rapidly sloughs. It at first contracts, and then, if the patient lives, inflammation begins, and the dead skin separates. The seat of the injury has also a marked influence on its risk, burns of the abdomen being more dangerous than those of the thigh, the wounding being equal, and burns of the hands more dangerous than those of the feet. Death may be due to shock alone, uncombined with the effects of the burning, in which case no internal evidence would be found on post-mortem examination; or it may be due to secondary inflammations, as pneumonia, pleurisy, or of the intestines. Perforating ulcers of stomach and intestines also result from wounds of this character, and the prognosis is not to be lightly given when a fair amount of injury has been done, as death may take place when everything is apparently proceeding toward recovery. The patient may sink under the exhaustion caused by the pain and shock, the collapse coming on suddenly. Where death is immediate from a general burning, it may be long before any great pain is suffered, for the shock may kill, or suffocation from smoke take place. In the latter case, the body being recovered in such state that an autopsy can be held, the usual appearances of death from asphyxiation will be present, while it is common to find where death has been from the shock of the intense heat or of the burns, the heart empty, the blood of a red color, and the organs generally congested.

As burning may be resorted to as a cover for crime, the medical examiner has to be prepared to state whether the wounds found were made before or after death. It is agreed by all the authorities on this subject that certain marks are fairly indicative of burns before death; but the question is on the same plane as other injuries, for the burns made at the time of death or immediately after present the same appearance, so that a decision can only be positive in a relative sense. Where certain

signs are present, such as the slough beginning to separate, there is no hesitation in saying the wound was made during life, for nature had to have time to form pus and commence the operation of throwing off the dead tissue. And the same may be said of lighter burns or scalds; for if we find evidence of the blister, which undoubtedly was caused, having been broken or cut away, and some pus-corpuscles lying on the healing surface, we know that life had gone on for twenty-four or more hours at the very least. The question, for the medical witness, is not of easy solution like the above. It is whether death took place either at the time the burn was inflicted or after it, and if after, how long a time probably elapsed between the two.

Blisters.—Blisters or vesicles are made by the application of heat to the surface of the skin, usually by boiling water, direct flame barely touching, or steam-jets; for where the injury is produced by heated metal or molten metals, or longer continued applications of flame, the skin is more deeply involved, and an eschar results. The vesicle in the cuticle at first turns white from the heat, and then rises from the surface. It is seen to contain serum, and the surface of the skin under it is intensely red. If pricked and the serum allowed to escape, it will wrinkle down upon the inflamed skin and remain there, if not rudely disturbed, acting as a dressing until the healing process has formed a new cuticle, when it comes away in dry scales; or it may again fill from more exudation. If torn off, the skin shows red even after death, in this differing from the removal of the cuticle by abrasion, the skin in this latter case drying a yellow or brown. The capillary congestion accounts for the red color, and this may and does become a red-brown color some time after death, but sufficiently different even then to be distinguished from the plaques resulting from abrasions. Experiments made by Sir R. Christison, Dr. Taylor, and others, show that vesications can be made on the dead body, but unless on dropsical subjects, air instead of serum is found in the blister. Bloody serum will be present if the blister is made directly after death, that is, within a few minutes. As with contusions, so with blisters: more heat is required to cause one in the dead than in the living, as more forceful blows were found to be required to produce an ecchymosis in the dead which resembled one made in the living body. The serum effused into a living blister coagulates when heated or on the addition of nitric acid; but that in a vesication produced on the dead, even if life has but departed within a few minutes, is more watery, and is merely rendered opaline by the use of the above-named agents.

Boiling water poured on the dead will not produce a blister. It shrivels the cuticle, but does not produce effusion of serum. Some fifteen years ago I was called to perform an autopsy on the body of a boy who had died at the Elmira Reformatory. The statement received from the prison was that he had committed suicide by hanging in his cell; that he was discovered before life was extinct, cut down, and every effort made at resuscitation, but in vain. At various points on the body, especially the prominent joints, such as elbows, knees, and other exposed portions, were reddish brown spots, varying in size and extent. Careful examination showed these had been made by heat. There were no blisters, however, but the color of the spots was such as to lead to the conclusion that they were slight scalds made while life was present. Further inquiry from those conversant with what was done at the reformatory when the boy

was found hanging, disclosed the fact that one method used for resuscitation had been emersion in a hot bath. In the excitement attendant upon the matter, the water had been made too hot, being boiling, or nearly so, and as the boy was plunged in, this being discovered, he was immediately taken out. The points slightly vesicated were in contact with the metal lining of the tub, which had become very hot from the water. As the autopsy disclosed evidences of strangulation and death from that cause, the explanation of the scalded spots was probably correct. Vesication does not always immediately follow the injury. It may appear in a few minutes, and it may not appear for hours; therefore, a patient may die from the shock or exhaustion before blisters appear, and after death they may come on and contain serum, the capillary congestion having taken place during life. The appearance of the skin under such a vesicle will be a guide as to the period the burn was received.

More serious burns, those when an eschar is produced from red-hot solids, molten metals, or flames, show more marks than vesication. The part burned—that is, the skin—turns white. Around the spot is a sharp red line, and generally redness of the skin beyond that again, which gradually fades into the normal color. This inflammatory blush, if pressed on, disappears under the pressure, returning again as soon as the pressure is removed. The deeper red line, resembling the line of demarkation around a slough, will not yield to pressure, and remains present after death. The attending blush, however, fades entirely when death takes place. While this red line is a mark of a burn during life—for there are no satisfactory experiments recorded that show it can be produced on the dead, it being caused by deep injection of the true skin—its absence is not proof that the burn was made after death, for it is not always present in such wounds produced in the living. Its presence, then, is fairly reliable proof that the burn was made while vitality existed.

Bodies may be so destroyed by fire as to preclude any autopsy, or any judgment being pronounced as to the cause of death. All appearances in one so cremated are to be observed, especially those relating to sex. If the body has been rescued before more than partial destruction has taken place, the autopsy may reveal much or little, for if death is from shock, with the exception of the conditions before noted nothing will be seen. If, however, death has been produced by other means, and the fire has been caused to hide the crime, the examination of the remains will in all probability reveal the facts. Burns which are severe in character may cause fissures in the skin, which have the appearance of incised wounds. The reason for the fissure is the destruction of the elasticity of the skin and its being desiccated by the heat. While the skin gives way, the cellular and fatty tissue below, being intimately connected with it, may also part, so that the apparent cut may show the muscular tissue. Examination of the tissue, however, will demonstrate the difference from wounding by the knife, for the edges are more uneven, the fissure may extend in one direction and then go off at a tangent, and the condition of the deeper tissue will also aid in the decision.

Corrosive Liquids.—A medical witness may be asked to state whether a given wounding was by the application of heat or some corrosive fluid. While both are called burns, the latter are not properly so. Usually, the color of the wound is a guide to the cause, those made by sulphuric acid

being brown, while nitric and muriatic acid give yellow stains. As these injuries are generally made with malicious intent on the part of another, the most common seat is the face and hands. There is no blistering, and the eschar is colored, and without either the red line or red blush. The skin touched is killed and sloughs away, healing taking place by granulation. Generally these wounds are not dangerous to life, but the attendant inflammation may become so. It is not found that ulceration of the intestines follows these injuries as it does burns from hot substances, and consequently, while disfigurement follows them, they are not so serious in prognosis.

Fractures and Dislocations.—With these classes of injury all surgeons are familiar, but all those who have to do with legal cases in which such injuries come are not equally well informed with the medical man. And both classes are met with from criminal violence, either as the direct result of the violence, or as an indirect one, for the force which causes a fracture may exert itself in different ways. A fracture is the break of a bone, and divided into classes, according to its character or its cause. A simple break is where the bone is at some point of its course divided into two fragments, and it may be caused by a blow or pressure exerted opposite the place of the break, or it may be from the force being transmitted to this particular bone and expending its energy there in breaking it. In the first case, it would be called a direct fracture, in the second, an indirect. As an example, the arm-bone may be broken, at any point between the shoulder and the elbow, by a blow from a club: this would be a direct fracture. A man might fall and land on his feet, sustaining a fracture of the neck of the thigh-bone: this would be an indirect fracture. If the bone is broken in more than two pieces, it is called a comminuted fracture, and this does not mean, as the name "comminuted" would seem to imply, that the bone is crushed into small pieces, but that it is divided into three or more fragments, broken in more than one place. The break may be said to be compound when the soft parts leading to the seat of fracture are lacerated or cut, and the wound leads from the outer air to the break. This laceration may be either done from without in, by the force making the fracture, or from within out, the force driving one or more of the fragments through the skin. If the laceration or cutting of the soft parts does not reach to the break itself, or a dislocation of one end of the broken bone from its joint-socket is present with the fracture, then the injury is called complicated, by the additional wounding or by the dislocation. And this complicating of a fracture may be done in more ways, for one end of a fragment may wound a nerve or blood-vessel, thus adding to the primary injury the complications of the secondary ones. A fall on the knee may produce another kind of fracture, comminuted, it is true, but taking its name more from its peculiar radiating line of cleavage; for the fall being received on the knee-pan, that bone may be broken in star-shaped form, and give us what is called a stellated fracture. This may also be found elsewhere, for a fracture from the blow of a hammer or other like weapon, or from a bullet, may cause a stellated fracture of the skull. The force which causes the break may drive one part of the bone broken into another and hold it fast. This, while an indirect fracture, is known by the name of an impacted one. And lastly, fracture may be in the line of the bone's axis, longitudinal splits, either clipping loose a project-

ing part of the bone, or splintering the shaft itself. These are generally the result of gunshot injuries, and when so are also called compound, as the wound of the bone opens by means of the wound of the soft parts to the outer air.

Fractures take place in some persons much more readily than in others. In an old person the bones are more earthy and break easier than in the adult, and the force being equal, the young breaks easier than the adult, because in the latter the bones are at their strongest period. In the child or young person the bone may bend, partially breaking on the periphery of the arc, giving what is called by writers "the green-stick fracture." And in the young the epiphyses do not unite to the diaphyses until certain ages have been passed, all the epiphyses not becoming bone until about the twenty-fifth year; consequently, there may be a separation of one of these ununited epiphyses, which to all intents and purposes is a fracture or break. Certain diseases or conditions of the system, resulting from disease or medication, predispose to fracture: mollities ossium, cancer, syphilis, rickets, gout, scurvy, mercurialization, and any disease dependant upon cachexiæ. These facts are to be borne in mind, for the wounding may be increased in severity by their presence, and yet the responsibility of the assailant be not, and the assault not be aggravated.

Fractures may be spontaneous, and caused by the action of the muscles attached to the bones so breaking. Commonly, those bones peculiarly exposed to the violence of suddenly contracted muscles are the ones broken in this way, but the long bones, such as the bones of the arm and thigh, have been fractured in this manner. If the patient suffers from fragile bones, breaks may take place by turning over in bed. Breaks thus made are the simplest kind of fracture, the bone merely parting, and not causing laceration of the soft parts. Where the fracture is from any violence or force, either directly or indirectly exerted, the fragments lacerate the soft parts surrounding the break according to the degree of force experienced. This wounding is a guide to the decision of the time it took place, for if much bleeding follow the tearing the probabilities are that the break was during life. The muscles may be torn as much after death as before it by the fragments, but unless a vein be cut across, less hemorrhage will take place in the dead than in the living. A fracture made at the moment of death, or immediately after it, could not be told from one made at a corresponding time before death; but if the body has been dead a short while, say from ten minutes to half an hour, the appearances around the broken ends of the bone will show life to have been extinct when the wounding took place. If the fracture be of some hours' or days' standing before death takes place, then the examiner can give a positive opinion, for, as in wounds of the soft parts by other instruments, Nature is getting ready to repair the injury she has received, and the signs of this work are apparent.

As to the Cause of Fracture.—The medical witness may be asked how a certain fracture was produced, whether by a blow or by a fall. The defense usually claims that the attack of their client did not cause the break, but it was the result of a fall. The first thing is, was a weapon used? If so, what kind? Of course the answer is easy if the wounding was by means of powder and shot, for then we have the wound of entrance to reply to the question of time of occurrence. If extensive con-

tused or lacerated wounds, and it may be incised ones, are present, with the fracture directly in the track of the force making the wounding, we have but to find the weapon, club, stone, pistol-butt, gun, hatchet or ax, and the whole story is ready for recital. Leaving aside weapons which divide the skin, we consider ones making contused wounds. Here the extent of the contusion on the soft part is not only indicative of the weapon, but also of the amount of force used. Taking the bruise of the muscles into consideration, the extent and depth of this bruising would show that a fall could not have produced the wounding, for undoubtedly as the break was caused at the same time as the contusions, it being a fracture from direct violence and in line of the external injury, the impossibility of a man falling so as to cause just so much violence in one spot, without corresponding injuries which would be naturally and necessarily received by the same fall and at the same time, the breaking by direct violence, and that from a weapon, would be clearly shown. This presupposes careful examination of the place where the assault is stated to have taken place, as well as of the wounded limb itself. If the wounded man is suffering from fragile bones or from any cause which renders the resistance to force less strong than normal in the bones breaking, it is no aggravation of the assault, for the force used was probably such as would in no way break a bone in an ordinary man; and as no intent to do such severe injury is shown, the responsibility for the break would lay with the assailed. If he did not have a condition which rendered his bones brittle, he would not have had them broken, for the force used was not sufficient to break a like bone normal in its condition.

Fractures of ribs may be made by blows on the sides, by compression, as by a person jumping on another. The fracture, like those in the long bones, is either at the point where the force impinges, in which case depression of the fragments may follow and the lung be wounded, or by the transmittal of the force around the rib until it extends itself at the angle. In this case the fracture is outward, and no danger of wounding the pleura need be feared. When the injury is by compression, more than one rib may be found broken, and at different points. Unless the pressure is sharp and sudden, the angles of the ribs suffer the most. Quick, direct pressure, so strong that the natural spring of the rib is overcome, will be apt to make a break at the point of application. In 1882 a man was tried for the supposed murder of a boy who worked for him. The case was tried in Schoharie, N. Y., and the people presented the following: That on a Sunday afternoon the farmer, finding his sheep had strayed from the paddock, the bars of which had been left down, told this boy to go and bring them back. The house stood by the roadside. Across the road was a pasture leading down an incline to some brush and small woods, in which ran a little stream, and also contained more or less swamp. The sheep having gone in that direction, the last seen of the boy was his entering the woods. He never returned, and some inquiry was made, but the conclusion reached was that he had run away, for the short cut to the village lay through these woods and across the fields beyond. The boy was about thirteen years old, lame in the left leg, that limb being shorter than the right, of light hair, dressed in brown overall trousers, a shirt, and an old jacket. It was late in September, and frost was felt at night.

The following spring a man, following the by-path to the village, was

somewhat startled to see a small human skull grinning at him from between two bars which on a line-fence crossed the brook. Remembering the disappearance of the boy the autumn before, he gave the alarm, and search revealed the following: Further up the stream, which from the melting snows had quite a volume, on one bank was found some scalp with hair adherent, and part of the skin of the back of the neck. This was shriveled and dry, showing the appearance of having been alternately wet and dried until it had been left where it was found by the waters going down. In different places were found bones, and as excitement grew and different persons engaged in the search, many bones were found scattered over quite a territory, and belonging to different animals. The whole of the boy's skeleton was not found, but enough was to make out height and age, and that the left femur was shorter than the right. Nearly all the left ribs were recovered, and some of the opposite side. The lower jaw was not found, nor were any bones of the hand, while only a few vertebræ and foot-bones were among the remains. The long bones all gave evidence of having been chewed by some animal, and the ends of both ulnæ, the head of one radius, and both ends of one fibula were thus eaten off.

The medical witnesses for the people and defense agreed as to what were human bones, the age and size of the skeleton, but differed as to the two main facts—one, the probable cause of death, the other whether the body had been buried. On this latter question turned the guilt or innocence of the prisoner, for if the boy had been placed in a grave, murder had been done. The expert for the people thought death was due to a blow over the left chest, which could have been made by a hoe or some such instrument, and marked three ribs of that side, the third, fourth, and fifth, as being the ones struck, and showing this by a slight line of fracture, not complete, but still apparent, which went across each. The doctor also thought the body had been buried, and dug from its shallow grave by foxes or dogs. I could not agree with this theory, and chiefly because if these lines of fractures on these three ribs were made by a blow from a hoe, how came similar lines on all the other ribs found, ribs belonging to both sides of the body? Nor did I agree with the theory of burial, for evidence of great unanimity on the part of the dogs and foxes which dug up the body must have been present to scatter the bones in the way they were found, and to chew only certain ones. The ribs had much more the appearance of having been frozen in ice, for when carefully scanned the lines of fracture were such as would be made by some general pressure in a straight line, the body on its back. The jury took the same view, for they rendered a verdict of acquittal within ten minutes after retiring.

Fractures of the bones of the skull differ from those of the long bones in that there is generally more than one line of break. And commonly these fractures are from direct violence, either by falls, blows, or bullets. It has already been seen what effect a ball has upon the head and upon bone itself. When the break is by a blow, unless a soft weapon or a large one has been used—large in the sense that its striking-surface does not hit one line of scalp—the fracture is not usually compound. The soft parts may be contused to a considerable extent, the bone broken beneath them, and still the skin be not lacerated. The line of fracture in such case may be single, following the course the force of the blow

would take around the skull, or it may be multiple, one line going around, the other passing inward through the base. Whether such an injury is from a fall or blow will be known by the presence of the contusion, and the seat of this will lead to the statement to which class of cause the wound is to be attributed. If the contusion is either in front or behind, it is as easily made by a fall as by a blow, but on the side the probability is in favor of a blow, it being more difficult to receive such injuries on the side of the head from a fall, the shoulder being apt to interfere. Still it is by no means impossible, and therefore the medical witness must be guided in his opinion by attendant evidences, such as the character of the contusion, the place where the alleged fall is said to have taken place, what object the head could have struck, and any other circumstance that bears upon the case.

Fractures of the base may happen from a fall on the feet, the force being transmitted upward so rapidly that the base is broken by contact with the condyles. In such an accident it will not be difficult to show no homicidal assault was made upon the head. Fractures of the head made by hammers, hatchets, and other like weapons are characterized by the article producing the wound. A sharp-pointed tool, like a pick or the pointed end of a fireman's ax, will make a depressed fracture, oftentimes driving before it a piece of bone, with hardly any lines of fracture in the rest of the skull. The size of the hole and shape, for it is nearly if not quite square, is a guide to the manner of its production. The cut made by a hatchet or ax is likewise indicative, for while extensive lines of fracture may be present, the cleavage made by the cutting part is distinct, and shows the kind of instrument used.

Dislocations.—Dislocations of the long bones are rarely fatal. They show less disturbance of the soft parts at the point of luxation than that made by the ends of broken bone, for the smooth articular surface is not disarranged, and the bone tears its way through the capsular ligament and then usually stops. There is not, therefore, as much effusion of blood as in fractures, and the injury is not so severe. If, however, the luxation is of a vertebra, then the injury is dangerous and may be instantly fatal, according to the amount of pressure exerted upon the spinal cord. These injuries are more common in the cervical region than elsewhere in the column, and if the luxation is sufficient to cause pressure on the cord, are attended by paralysis, if not death. They are accidental rather than homicidal, for even if caused during an assault, the assailant is not usually of the class that knows such an injury could be produced by certain bendings, and if he creates it, it is more by accident than design.

Position of the Body when Wound was received.—The medical witness may be asked to determine the position the body was in when the wounds found were received. In many cases it can be readily understood the wound would give no positive evidence of how the assailed stood or what position he assumed when struck. A contused or lacerated wound of the head could be made on the person standing, sitting, or lying down. Again, the wound could only be given with the body in some position which would allow of the full force of the blow being delivered where its effect is found. Stab and gunshot wounds are more apt to give evidence of the body's position than other injuries, for here the direction of the wound gives some clue to the position of both assailed

and assailant. In the case of Woods, the evidence of the course of the ball showed he received the wound in two ways, either semi-inclined, as claimed, or erect, the shot coming from above. It was impossible for the bullet to have been fired at right angles to the body, for it could not have taken the course it did, as nothing hit by the ball deflected it, the line being perfectly straight from the wound of entrance to the spot where the ball was found. In 1892, in Greene County, a negro named Bedell was shot and killed by a man named Hess. It was in a country hotel bar-room. Bedell, who was a powerful man, engaged in a fight with another and knocked his opponent down, rendering him insensible. He was then going to attack Hess, who was behind the bar, when two others seized him, one on either side, and a struggle ensued. Bedell broke away from his would-be captors, and at the instant he freed himself Hess fired. Bedell stopped, turned and walked to a billiard-table, about twelve feet away, leaned against it, then walked to a chair about twenty-five feet from the table, into which he sat. While sitting there the man whom he had just knocked down recovered his senses, and made an assault upon the negro, striking him over the head with a pistol-butt. Men interfered to prevent further fighting, when Bedell got up, walked forward about eight feet, and struck his assailant a strong blow in the face. Then he went to the chair and lay down on the floor, exhaustion coming on. The whole affray only took five minutes. Bedell went into a state of collapse. I am indebted to Dr. A. Beach, of Coxsackie, for the description of the wounding. Dr. Beach states that the ball, which weighed ninety grains, entered by an oblique wound a little to the left of the median line, passing over the cartilages of the sixth and seventh ribs, then through the left lobe of the liver into the stomach, and out again nearer the pyloris, through the transverse colon, six times through the small intestines, and lodged in the right psoas muscle near to the promontory of the sacrum. Here, as in the case of Woods, from the line of the bullet the man could not have been in the erect posture. Nor was he lying down. The track made shows he was bending forward, probably the last effort he made in breaking away from the two holding him, and in this position the bullet struck. If one tries the position it will be seen that the ball could wound just the viscera that were found injured, the bending of the body bringing them in such relations that the bullet would make a straight course from its entrance to its resting-place. In the case of the man killed at Mechanicsville in 1882, the wound could have been received either standing, sitting, or lying down, for it was a blow on the temple, and nothing gave evidence from the wound in what position the body was when it was inflicted. Other facts that could be adduced had to be shown to prove the body was standing when it was struck.

Did the Person move after being Wounded?—It may be of importance to know how much a wounded man, one "wounded unto death," can move or accomplish after he has received the injury. The medical witness may be asked the question if, in his opinion, it was possible for any voluntary movements to take place after the receipt of a given wound; and the question is not always one where a positive yes or no can be given for answer. Men differ in this regard as much as they do in others, some falling to the ground from a comparatively slight wound, others fighting until nature is exhausted by hemorrhage or other cause.

Some wounds are, of course, instantly disabling, no matter by whom received. A rifle-ball going through the head would, by the force of the concussion alone, without taking into account the injury to the brain, render the patient insensible. A heavy blow on the head or neck from a sand-bag or other weapon would cause insensibility, or instantaneous death could follow stab-wounds of chest or abdomen, as well as gunshot injuries. But the cases cited have been sufficient to show that mortal, and what would ordinarily be considered paralyzing, wounds may be suffered and still violent exertion follow. Woods, with blood pouring out of the wounded right auricle, broke an iron bolt and ran nearly a quarter of a mile before falling. Bedell walked about and began again to fight, although the wound he had received cut the mesenteric arteries, and blood and the contents of the intestines were being discharged into the peritoneal cavity. Here are two wounds, both mortal, and yet both borne without any apparent effect for some few minutes, and the recipients doing that which a medical witness, not knowing the evidence, would have felt justified in saying would have been a physical impossibility for either to perform.

When serving as dresser in the Montreal General Hospital in 1867, a fire breaking out, a panic started among the patients. When the fire was over, a woman who had a fracture of both bones of one leg, and who had been dressed in the old fracture box, was found in the main hall two flights of stairs down from the ward. How she got there she could not explain, but no one helped her, and in her fright she walked and ran. As soon as all excitement was over she was perfectly helpless, and could not move. Instances innumerable might be cited where men have fought for their lives after receiving wounds which were mortal; but it is only cumulative evidence, and enough has been said to show the need of caution on the part of the medical witness in stating that the deceased could not have moved after the receipt of his wound. It is but another illustration of how every circumstance bearing upon the death must be carefully sought for, and considered by the medical examiner before he passes an opinion.

And even wounds involving the brain are not always preventive of motion. The celebrated case, quoted in physiologies, of a man who had a blasting-iron three feet long blown through the anterior portion of his head, and who got up and walked to a cart, rode from the quarry to his home, walked upstairs and did not become insensible until he was in bed, is known to all. Had this man been found dead with such a wound, it would have been said he never moved from the spot where he received the injury, for such a wound would render him insensible, if it was not immediately fatal. A hasty expression of opinion as to the power of one seriously wounded to move, might cause an innocent person to be accused of the crime of murder.

Wounds affecting Special Parts of the Body.—The character and evidences of wounds in general have been now studied. It remains to see how injuries affect different parts of the body, and to look somewhat more closely into the question of how dangerous wounds in regions may be, and what influence they exert in causing death.

Of the Head.—Incised wounds of the scalp are not usually dangerous. If properly treated they heal readily, and the patient suffers but little inconvenience. A contused and lacerated wound of the scalp is a differ-

ent affair. These are dangerous, for the liability to inflammation and erysipelas is great. A patient who walked into the Brooklyn City Hospital during my service as resident surgeon died from inflammation of the meninges of the brain, resulting from suppuration of a large, lacerated wound of the scalp. The man had fallen about twenty feet out of a cherry-tree, tearing the scalp on the left side of his head so it hung down over the ear. The wound was carefully cleansed with disinfectants, the parts brought together by suture pins, the patient sitting on a chair and talking all the time his head was being dressed. Inflammation with suppuration followed, the periosteum was denuded, matters went on from bad to worse, until death ended the case. Here, apparently, was a simple wound, and one not likely to cause any danger to life, but it was a lacerated and contused one, and despite all that was done for the patient, a fatal issue followed.

Another danger from a contused wound of the head is the amount of injury done to the brain, and this cannot be at first definitely decided, for a slight injury will be followed by inflammation of the brain or its membrane and cause death, while one much more severe, even where a depressed fracture is present, may be fully recovered from, and no bad result be noticed as a sequel. A physician cannot prognosticate from the appearance of the wound, and therefore must call time to his aid before giving the dictum that the patient is out of danger. It is perfectly proper for a medical man, after the usual time for brain symptoms to appear has passed, and the wound is free from erysipelatous inflammation or undue suppuration, to pronounce the man out of danger, especially if pulse and temperature are normal. But the effects of the contusion may not yet be dissipated. The injury to the brain may go on to the formation of an abscess with no symptom until a sudden explosion, and the patient rapidly dies from the abscess, due to the original wounding. That the physician has pronounced the patient out of danger from the assault, and in a few days the man suddenly dies from brain lesion due to the blow, is no reflection on the skill of the doctor, as all symptoms of regaining health were present, and none of special brain injury.

A severe blow to the head gives concussion. The degree of this is according to the force of the blow and the individual struck, but it may ordinarily be considered that a violent blow is followed by some amount of concussion, effusion of blood, or both. The blow may be so severe that the recipient falls and dies at once from concussion alone. The autopsy would show no cause of death, and there might be nothing more than a small contused wound of the scalp to indicate that violence has been done. Concussion comes on immediately, and may vary in intensity from a slight dazing to insensibility, followed by vomiting, or a state of coma lasting for some days, until death takes place. If the concussion does not of itself prove fatal, it may be followed by brain lesions in the same way as contusions. Like the others, the secondary injuries are but sequels of the primary one, and responsibility for the original wound is also responsibility for the effects. The condition of concussion may be mistaken for intoxication, and the medical witness may have to decide between the two. This is not always easy to do, especially if a history of the case cannot be obtained. The fact that there is a smell of alcohol about the breath is no proof, for a person may have taken spirits and received a concussion afterward. Where concussion is slight, the

patient may walk as if intoxicated, talk unintelligibly, act in an aimless manner, and be totally unconscious of what he is doing, simulating drunkenness so closely that an ordinary observer would unhesitatingly pronounce him intoxicated; and yet all is due to the effect of the blow. If a man dies while in an extreme state of intoxication, the brain does not show more than it does after severe concussion, no rupture of vessels having taken place. Contusions may be found on the head in both cases, alcohol may be found in the stomach in both, the brain is equally congested, and so are the other post-mortem appearances similar. The medical examiner can only, the body living, await further developments in the case; the body dead, gather all evidence possible from circumstances. It is necessary to treat all such cases with the utmost caution, and to carefully note all facts that may develop. Cases are constantly reported where persons have been arrested for being drunk and disorderly, put in a cell, and found dead next morning, the autopsy showing fracture of the skull with effusion of blood as the cause of death, and proving the prisoner not to have been drunk at all.

Extravasation of Blood from a Blow.—A blow on the head may cause extravasation or effusion of blood, which, from its pressure, becomes the cause of death. As said elsewhere, contusions of the head may result equally from blows or falls, and as the contusion precedes the concussion, the latter and its effects may be ascribed to a fall as well as to a blow. Supposing a blow is struck which knocks the person receiving it down. This blow, while severe, may not be strong enough to give more than a slight contusion. But in the falling the head receives a violent concussion, and the man dies. While the concussion is not directly from the blow, it is a result of the blow, for the fall would not have taken place if it had not been struck, and the concussion, therefore, would not have been suffered. To the medical witness it makes no difference whether the concussion results from a blow or a fall; he has but to describe the condition he finds, and state to the best of his knowledge how the lesions causing death were received.

When the effusion is due to the injury it is most commonly from rupture of a meningeal artery. This may be ruptured by the force of the blow even without fracture of the skull, and where a clot from a meningeal artery is found, causing pressure on the brain or its base, it is more apt to have violence for its cause than disease, therefore attention is called to other matters in the case, and a hasty opinion that death was due to an apoplexy prevented. The blow causing the effusion may make so little contusion as to escape notice; or if on division of the scalp some ecchymosis is apparent, it might be assumed that this was due to a fall and followed the effusion, instead of preceding and causing it. Spontaneous rupture of these arteries from disease is rare, and this fact being known, the medical examiner, finding such a cause of death, has his suspicions aroused, and should make inquiries to show what led to the artery breaking. The blood, when the effusion is from one of the meningeals, is between the inner table and the dura mater. If the effusion is large, death may be rapid; but the brain will stand a great deal of pressure at all other points than the base, where the medulla may be impinged upon, and the effusion may be not sufficient in amount or it may be spread over the whole side of a brain, and in this way not give the amount of compression necessary to cause trouble; or, in fact, it

may not make its presence known at all. In the Mechanicsville case the clot found was from the right meningeal artery, and was as large as the hand. It showed not only its origin and cause, but also that it was a fresh clot, death supervening before any changes could occur in it.

A person receiving a severe injury to the head may recover its first effects and be apparently on the high-road to his original health, when he suddenly becomes worse, goes into a state of coma, and dies. The autopsy may show clots more or less extensive in the cavity of the ventricles, or over the brain surface and dipping into the sulci. The condition here arises from the contusion, some vessels being ruptured, and the blood slowly escaping. The clot will show that it is not of late origin by being partially organized and of different colors, and its time of beginning can be drawn to or near to the time the contusion was received.

Is the Effusion found from Violence or Disease?—Hemorrhage may take place from violence in almost any part of the brain, for the blow may rupture the brain or it may cause effusion into its substance into the ventricles or about the base. And similar bleedings may have disease for the cause. If a man dies after a fight or fall, and an introcranial hemorrhage be found, the medical witness may be called on to state which cause, the blow or disease, gave the effusion of blood. Much may depend on his answer, for a person innocent of crime may be placed in a serious position because he was engaged in the brawl and his opponent died after it was over. In 1880 two policemen in Albany were summoned to arrest a man who was creating a breach of the peace. The fellow was drunk, or had been, and was ugly, as the stupefying effects of the liquor were passing off. His age was a little over thirty years. He refused to be quiet when the officers appeared, and they started to take him to the station-house, about three quarters of a mile distant. The man fought, and the patience of the officers becoming exhausted, one of them used his club, hitting his prisoner over the right temple. He was only hit once or twice, the skin was not cut, and no fracture was caused. The prisoner continued his struggles all the way to the station-house, but was not struck again. After his name was put upon the blotter, he fought the officers to the cells, and until he was pushed in one and the door locked. Then he continued to swear and abuse them as long as they were in hearing. The arrest was late in the afternoon. The watchman saw and spoke to the prisoner in the evening, getting curses for a reply. He saw him again before midnight, when he stated that the man was asleep and snoring. In the morning the prisoner was dead.

An autopsy was held by the coroner's physician, and he stated that he found the contusion with a clot under the muscle; no fracture of the skull, no break of the skin. On opening the skull nothing was found external to the brain, but on section a clot, evidently from the branch of the right anterior cerebral, was buried in the right lobe. The rest of the autopsy did not show very much, according to the doctor's report, and he gave as a cause of death the hemorrhage in the brain. When asked what caused the hemorrhage, he stated that, in his opinion, it was the blows the deceased had received. This led to the arrest of the two officers, and the presentment of this case to the grand jury. The defense had the body exhumed, and further examination made. The statements of the coroner's physician were substantiated as far as the contusion and there being no fracture of the skull, but from that on I differed in the opinion

that the man was healthy. Both kidneys and liver were fatty. Specimens of the aorta, vertebral, basilar, and cerebral arteries were taken and put under the microscope. All proved the presence of fatty degeneration. The condition of the contused part was carefully examined. As considerable decomposition had taken place, it being the summer, the evidence from the contusion was not so conclusive as it was on the first examination, so questions were asked the doctor who held the first autopsy, concerning this and other points. Upon the statements made by him and upon the microscopical appearances, I gave the opinion the rupture was due to disease, and was not caused by the blow.

If this case is scanned, the reasons leading to this decision will be apparent. While apoplexy is not usual in persons under forty, intemperance and violent habits predispose to it, and consequently in such subjects the age has less to do with the effusion than the intemperate habits. The microscopical examination showed the arteries of the brain in an enfeebled state, by reason of fatty degeneration. This was undoubtedly due to the intemperance of the man; and as neither the examination I made nor the statements of the coroner's physician as to the evidence of the contusion showed it had been a severe one, one that would do injury to an ordinary man, the fair inference was that the rupture was not due to the blow, but to the congestion caused by his intoxication and bad temper and his struggles with the officers, a congestion too prolonged and too much increased by the constant struggling to be borne with impunity by the weakened vessels. The grand jury did not indict, and the policemen were released. Here, it appears to me, all the evidence points to rupture from disease. The blow was comparatively slight, the vessels were diseased, the man was a drunkard, was violent and excited, the cerebral vessels were highly congested from the time of his arrest until put in a cell, and the point of the rupture was in the brain substance. Had a rupture in that situation been the result of a contusion, the contusion ought to have been a more violent one than was shown to have been received. In deciding on these cases as to what produced the effusion, whether the violence or the disease, it must be taken into account whether the injury done is one that would cause a wound sufficient to harm one in ordinary health and who did not suffer from the effects of alcoholism. While the general rule may be followed that where the injury done would not give danger to a healthy man, the rupture is from disease, it should be borne in mind that ruptures sometimes follow quite slight contusions, and that cases are on record to substantiate this condition. It again comes back to the same story, viz., that the medical examiner must take into consideration all circumstances attendant upon the case before giving his opinion.

Wounds to the Spine.—Concussions of the spinal cord caused by blows or falls are more likely to be cases where a medical witness's services are needed in civil suits, and not such injuries as are subjects of criminal charges. It is, however, a legitimate condition for study, as injuries may be received to the cord which are either fatal or permanent, and be the result of criminal assault. Many cases of sudden death from injury, in which no appearances post-mortem are found to account for the death, might be found due to some injury to the spinal cord if it was taken out and examined.

We have found that the brain may suffer secondarily from a blow upon

the head, inflammation, softening, abscess, and death resulting. The spinal cord is of itself a nerve center, and in construction is analogous to the brain. What, therefore, will cause injury in one will in the other, and we may have varying degrees of injury from contusions to the spine or indirect falls or blows, which will cause concussion and temporary disablement to follow, to traumatic meningitis or traumatic myelitis and death. The lesser of these injuries are often made subjects of suits for damages, and many times the plaintiff is partially paralyzed in one or both limbs with interference with the functions of the bladder and bowels, recovering with wonderful rapidity when a favorable verdict has been obtained. But all are not frauds, and genuine injury is suffered from a concussion of the spinal cord. In 1879, a man who was a brakeman on a freight-train fell from the top of his car by the breaking of a brake-head. He was picked up insensible, and when consciousness returned he was found paralyzed in the lower limbs. The catheter had to be used, and bloody urine was voided for some days. He recovered the control of the bladder, the pain he had suffered disappeared, sensation and temperature were somewhat impaired in the lower limbs, but elsewhere were normal, and he got so he could walk on crutches. He sued for the injury and recovered, his injuries being considered permanent by the medical witnesses. His suit came to trial three or four years after the accident, and it was then I first saw the man. He had been treated in Albany, New York, and Hartford, being in hospital in all these places, but his legs only recovered enough power to swing back and forth, and, aided by the crutches, carry him along at a rapid walk. He could not raise the feet high enough to step upstairs, nor could he stand without his crutches.

I saw the man daily, for two years or more, at his post of gate-keeper on the New Capitol. He was fat and healthy, in every way perfectly well, excepting the want of power in the lower limbs. Losing his position in 1884, I lost sight of him, and did not see him again until 1891, when he came to my office on some errand, and told me he was going out shooting. His condition was the same as in '76 or '78, when I first examined him. He still had to use his crutches, for his legs would not hold him up without them; otherwise he was perfectly well, and with their aid he could walk far and fast. There was no symptom of fracture or dislocation of the vertebræ, and whether any existed of course could not be told. The case was undoubtedly a concussion of the cord with probably some hemorrhage in or about it, and the recovery was only partial.

From this to severer injuries inflicted with weapons or by falls, where more direct violence is done to the spinal column itself, is but a step, and the wounding to the cord may be so severe as to cause mortal injury, either within a few days or later, inflammation supervening, and complete paralysis interfering with respiration, bringing on death. The injuries may be by criminal violence or be accidental. The fact that they may occur is to be borne in mind, for the death may be an obscure one, no appearances to account for it being found on the post-mortem examination until the vertebral canal is explored, when the condition of the cord or its membrane will show why life ceased.

Where dislocation of a vertebra takes place the pressure on the cord may be so severe as to cause death at once, or it may only cause paralysis,

which, under treatment, may improve for a time and then suddenly grow worse, the patient sinking into coma, and death shortly following. This may be from inflammatory products causing increase of pressure, or from the formation of pus. This same condition may follow injuries from fracture of the arches or bodies of the vertebræ, even if after the fracture the fragments spring back into place, for the pressure would be so severe at the time of the primary displacement that the contusion sustained by the meninges or the cord would lead to effusion of blood from rupture of the vessels of the meninges, hemorrhage within the substance of the cord, or subsequent inflammation of either. The cause of the fracture may either be direct or indirect—blows, falls, crushes, or gunshot injuries all giving this result. In 1867 a case was brought into the Montreal General Hospital, in which I then served as dresser. The man was driving a load of hay under an arch, and was kneeling on the load. His head was bent, but not enough, and in some way not known he was caught by the arch; the horses kept on, and he was found insensible on the top of the load when the passage was finished. Being brought to the hospital, the diagnosis of an impacted fracture of some of the dorsal vertebræ was made. The man suffered some slight paralysis, from which he recovered, but when he was well and ready for discharge he had lost over an inch in height. I do not pretend to account for how the cord escaped severe injury, but merely state the case to illustrate the fact that severe fractures may take place in the back and recovery follow.

Fractures of the spine or severe injuries to the cord are more common from gunshot wounds than from other classes of injuries. Here, the bones not being broken, we may also have the direct cause of a fatal concussion, for the bullet may render such a blow to the vertebræ into which it drives, or to the intervertebral substance, if it lodges between two of the bones, as to cause hemorrhage within the cord. In the case of the man shot in the neck at Fonda, elsewhere described, the ball impinged upon an intervertebral disk and the man died of paralysis of the right side. What caused this, whether a clot or a piece of the left lacerated vertebral artery went up to the brain with the last flow of blood in that vessel and, lodging in some of the vessels of the right hemisphere, caused the paralysis, or whether, what I think more probable, the concussion gave hemorrhage in the cord substance, the autopsy was not carried sufficiently far to decide. It was certain, however, no fracture had been produced, and yet the bullet undoubtedly caused the paralysis and death.

Death may not always follow immediately upon fracture or penetration of the spinal canal by a bullet, although, where the cord is injured by the missile, movement of the part of the injured man below the point of wounding is generally impossible. The case of President Garfield is one in point, and I quote its description from Ashurst's *International Encyclopedia of Surgery*: "The aperture by which it [the ball] entered involved the intervertebral cartilage next above [the first lumbar vertebra], and was situated just below and anterior to the intervertebral foramen, from which its upper margin was about one fourth of an inch distant. Passing obliquely to the left and forward to the upper part of the body of the first lumbar vertebra, the bullet emerged by an aperture, the center of which was about half an inch to the left of the median line, and which also involved the intervertebral cartilage next above. The

cancellated tissue of the body of the first was much comminuted, and the fragments were very much displaced. Several deep fissures extended from the track of the bullet upward into the lower part of the body of the twelfth dorsal vertebra. Others extended downward through the first lumbar vertebra into the intervertebral cartilage between it and the second lumbar vertebra. Both this cartilage and the next above were partly destroyed by ulceration. A number of minute fragments from the fractured lumbar vertebræ were driven into the adjacent soft spots. On sawing through the vertebræ from behind, a little to the right of the median line, it was found that the spinal cord was not involved by the track of the missile. The spinal cord and other contents of the spinal canal presented no abnormal appearance. The fractured spongy tissue of the vertebræ was suppurating. The missile was lodged behind the pancreas. Secondary hemorrhage from the splenic artery had supervened, causing death seventy-eight days after the infliction of the wound."

And when the bullet cuts the cord death is not immediate, but may be deferred for some weeks. Immediately all power of motion is lost if the cord is divided below the point of injury, and the injury, causing paralysis, proves fatal from varying causes. The digestion may be so impaired that death is due to this, or asphyxia from interference with the muscles of respiration; or exhaustion from bed-sores and loss of functions may be the immediate cause of death. The bullet, where it has cut through the body of a vertebra, will be more or less upset. It may still be measured, for part will probably retain the circumference, and so allow of determination whether it could have been fired from the weapon with which the assault is alleged to have been committed; and the same remarks as were made when speaking of the Billings case, concerning the care with which the bullet should be examined, are equally applicable where a wound of the spinal column is made by a ball.

Facial Wounds.—Usually wounds of the face give deformity, and this may become a question the medical expert has to pass upon; for if an assault is claimed and the wound healed, the question of whether such a wound as is said to have been received would leave the mark in evidence will be asked of the physician. And the results of apparently trivial wounds are matters to be carefully considered. The injury received over the orbit may be but a small lacerated and contused wound, but the supraorbital nerve may be involved in the bruising, and traumatic neuralgia develop, converting a simple wound into one of serious nature. The eye itself is protected by being placed in a deep socket, which is surrounded by a strong ring of bone, and when a blow is struck upon the eye the ball is pressed by the muscles of the lids as far back into the orbit as possible, nature taking this mode of protecting the organ from injury. A penetrating wound of the orbit, however, may be a fatal one, for while the external bone forming the cavity is strong and thick, the plates lining it are thin and easily pierced. The roof of the orbit, the orbital plate of the frontal bone, is so thin as to be translucent, and any instrument which can penetrate the soft parts can also force this plate. In this way injury to the membranes of the brain, or to the brain substance, may be received, and while not always proving fatal at once, is liable to give from inflammation not only cause for alarm, but be the cause of death. And even if the orbital plate be not pierced, the inflammation and suppuration of the tissues around the eyeball may follow

All wounds, there- [illegible] wound is deep, dan-

[illegible] is broken, result in [illegible] integrity of the arch. [illegible] as to the blow [illegible] the gentleman [illegible] the hat being [illegible] felt after the [illegible] resulted. Pen- [illegible] results, for the [illegible] may partici- [illegible] ethmoid is of [illegible] difficult. The [illegible] wound it pri- [illegible] pression, or sup-

[illegible] of the face, aside [illegible] than wounds in [illegible] as far as the size of [illegible] across Steno's [illegible] in prevent-

[illegible] into the brain. [illegible] has torn [illegible] extent, but not [illegible] are to be ex- [illegible] brain, and the [illegible] Or by reason [illegible] with it disar- [illegible] The sight of one [illegible] senses may be affected. [illegible] destroyed [illegible] external meatus [illegible] of bone or [illegible] almost an [illegible] both sides, in- [illegible] the loss by [illegible] all be taken [illegible] injury of this

[illegible] and more fre- [illegible] is generally [illegible] They are not invari- [illegible] the knife too [illegible] the jugular. [illegible] missed fatal [illegible] from a [illegible] and at [illegible] wounds self- [illegible] already dwelt [illegible] to use greater force

than he who seeks his own life, and the wound will give evidence of this fact. Then also the cut is as often from right to left as *vice versâ*, and proof being adduced to show the deceased was right-handed, would give suspicion of murder rather than suicide.

Stab-wounds depend, of course, upon what the weapon divides as it is driven in. If the blow misses its mark by the assailed turning or from whatever cause, a slight wound may result, the knife only passing through muscular tissue without severing any vessels, trachea or œsophagus. These wounds are almost always homicidal, and from their position, on right or left side, struck probably from behind or in front. The evidence of the wound will lead the medical examiner to the conclusion of the assailant's position. They are dangerous wounds, and if dividing the large vessels, almost immediately fatal. When the weapon is driven with sufficient force and by chance takes the proper direction, the spinal cord may be severed, the blade passing between two vertebræ. In such case the assailed drops at once, for if not instantly killed, he is instantly paralyzed below the section.

When the wound is from a bullet it is generally fatal, especially if the shot is from the front, as in this position there is more chance of its cutting vital parts. If, however, the ball passes only through the muscle, say, for example, the sterno-cleido-mastoid, the wound is not a dangerous one; but if it approaches nearer the median line, the danger increases the closer to the center it comes. If the patient survive the shot, permanent injury may result, for where it is in the lower part of the neck some of the cervical plexus of nerves may be cut through, and more or less paralysis of the upper extremity of that side follow; for, as stated before, a bullet kills the tissues it plows through, disintegrating them by the force with which it is driven, and a nerve severed by a ball does not heal again as one divided by a knife. By injury to the windpipe or gullet deglutition and respiration may be permanently impaired, and these probable results must be taken into account in deciding upon the danger of the wound and the extent of the injury.

Wounds of the Chest.—Superficial wounds of this region require but little if any attention, for unless the wound penetrates the cavity the danger is small. Hence, contusions are, however, more serious, for from them fracture of the ribs or sternum may take place, or rupture of internal organs. When speaking of fractures, the break of a rib from direct violence was stated to occur opposite the point of the contusion, and here the danger is that the fragments are apt to be driven in by the force used, perforating the pleura, if not the lung itself. In such a case emphysema may follow, or inflammation of the tissue injured. On Christmas, 1871, there was brought into the surgical wards of the Brooklyn City Hospital, of which I then had charge, a young man who was found by the police insensible and injured. Examination showed a long list of wounds, and among others fractures of two ribs of the left side. The general injuries comprised lacerated wound over left eye, punctured wound behind left ear and on left cheek, fracture of left clavicle, scapula, and ribs, dislocation of right clavicle from the acromion, dislocation of the cartilages of left ribs from sternum, frozen hands and frozen feet. The evidence of the injuries showed the man, while lying on his right side, had probably been jumped upon, for all the direction of force was from left to right. The fractured ribs had punctured the lungs and em-

physema began, but did not spread further than over the left breast, and a little on left side of the neck, for traumatic pneumonia developing, the inflammation shut up the puncture through which air was escaping. Despite these serious injuries and the operations on hands and feet that had to be performed to remove the frozen fingers and toes, the man made a good recovery. The heart as well as the lungs may be injured by a broken rib, and when so, a fatal result is to be expected.

When the wound is to the lungs, the first element of danger is from bleeding. The force of the blow, while it may not fracture a rib, may rupture a lung, and death from hemorrhage follow. And such an injury may also be due to a fall or to a crush, where great weight may pass over the body, such as a carriage-wheel. If the wound is from a weapon, a knife, for instance, the injury to the lung may be comparatively slight, and yet death ensue; for these wounds bleed more than their extent appears to warrant, and how much blood is being lost cannot be determined, the blood running into the pleural cavity rather than out of the external wound. If the stab divides one of the larger vessels, then the patient generally sinks rapidly; for, as shown in the autopsy on the body of Woods, the blood may fill the entire side of the chest cavity, compressing the lung to its smallest circumference. If air can escape from the wound, the diagnosis of the deeper wounding involving the lung is made by bubbles being mixed with the blood; the blood is frothy.

While wounds to the parietes are generally of little danger, gunshot injuries may leave such conditions as cause a positive crippling of the patient, especially where the missile tears more substance than a simple bullet would. The sequelæ may be a contracted condition of the chest walls, impairment of respiratory movements, pleuritic inflammations with adhesive exudations, and cough and pain follow, to shorten the days of the sufferer. If the ball or shot penetrate the chest cavity, the fatality is much greater, and generally the person shot survives but a short time after receiving the wound. The *Surgical History of the War of the Rebellion* gives, however, instances in which wounds of this character were recovered from, where ordinarily it would be considered the injuries were fatal. Private Charles P. Betts was struck by a three-ounce grape-shot at the battle of Fredericksburg. The sternum was comminuted at the bend of the third rib, and the costal pleura torn through. The arch of the aorta and its pulsations could be plainly seen through the wound. The man recovered, but in 1872 reported the wound was not perfectly healed, the left lung weak, and that he suffered somewhat from dyspnœa.

In 1864 Private Steele was wounded by a round ball which entered upper part of sternum and lodged under left scapula. He recovered, but with permanent interference with motion of the arm and with hemorrhage of the lungs. This condition was reported in 1869.

A remarkable case was that of Lieutenant-Colonel Lewis, who was wounded at Port Hudson in 1863, by an iron grape-shot weighing half a pound and being an inch and a half in diameter. The shot entered just above the right clavicle, fractured that bone, passed downward through apex of lung, passed out of chest about third dorsal vertebra, breaking the ribs, and lodged under the skin on the left side of the spine near the fifth dorsal vertebra, from whence it was removed. This man recovered, but the wound was not healed for a year, and several pieces

of bone had to be removed. Air could be blown out of both wounds of entrance and exit until they closed. In 1865 he was reported by the pension examiner as having his right arm very weak, some cough at times, and a good deal of tenderness on right side of chest.

These cases could be multiplied many times, but they are sufficient to call the medical examiner's attention to the fact that while such wounds are highly dangerous, they are not necessarily fatal, and it further again emphasizes the fact that care must be exercised before pronouncing injuries necessarily ones from which death must result.

Wounds of the Heart.—Blows or severe contusions may rupture the heart the same as rupture may occur in the lungs. The death is caused by two factors: one, the bleeding; and the second and more potent, the hydrostatic pressure of the blood, preventing the movements of the heart, for the rupture does not involve the cardiac sac, and it being inelastic, the blood exerts so much pressure the heart cannot work. Pressure from vehicles or weights on the chest may cause rupture, and it may also come from natural causes or disease. Severe pressure is therefore to be carefully looked after, for while no apparent injury is to be seen externally, we may have a lesion which will cause death as a result of the sustained force. Like every other class of wounds, exceptions are found, and these serve but to enforce the meaning of the proverb, "What's one man's meat is another man's poison." I remember a case which was brought into the yard of the old New York Hospital in 1869, when it was on Broadway. I was serving as a substitute on the surgical division, and happening to be alone, was called to see a patient just brought in by the police. Going down to the yard, I found a man lying in a push-cart, insensible, very pale, and evidently suffering from shock. Asking the accident, the officer stated that the man had been pushing his cart along Broadway when he was knocked down by an omnibus and run over. The mark of the wheel was plainly to be seen on the patient's clothes, and the track extended from the right hip to the left shoulder, passing directly over the heart. No fracture could be found. I went to report the case to the superintendent and get the order for his admission.

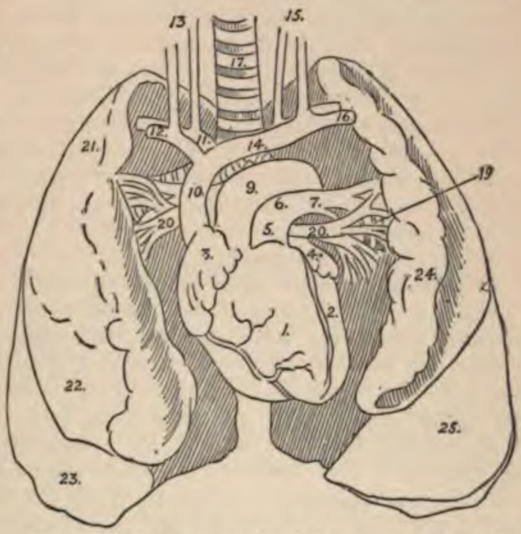


Fig. 72.—1, Right ventricle; 2, left ventricle; 3, right auricle; 4, left auricle; 5, pulmonary artery; 6, right pulmonary artery; 7, left pulmonary artery; 8, ligaments of the ductus arteriosus; 9, arch of aorta; 10, superior vena cava; 11, arteria innominata; 12, right subclavian vein; 13, right common carotid artery and vein; 14, left vena innominata; 15, left carotid vein and artery; 16, left subclavian vein and artery; 17, trachea and windpipe; 18, right bronchus; 19, left bronchus; 20, pulmonary veins; 21, superior lobe of the right lung; 22, middle lobe; 23, inferior lobe; 24, superior lobe of the left lung; 25, inferior lobe. (After Taylor.)

When I left, the man was still insensible. When I returned, after an absence of about six to ten minutes, I heard a shout of laughter in the yard, and there was the man on his feet and using language more forcible than polite, at being detained until "some fool doctor" would let him go, and he not hurt. He went, pushing his cart before him, nor did he thank the policeman who had pulled him out from his dangerous position, or the "fool doctor" who tried to make a patient of him.

When the wounding is by stabbing, it is usually instantly fatal. The shock and the hemorrhage both bring about the result. But the stab may be by a small-pointed instrument, or the point of the knife may wound the muscular tissue of the heart without penetrating the cavities. In such case death may be deferred for some days, and be due to inflammation caused by the wound. A small puncture may bleed but little, and only as the contraction of the heart allows the muscular fibers to come into the position in which they were at the moment the stab was received. This bleeding may continue for some time and death follow.

Gunshot wounds of the heart are almost always instantly fatal. It is not the invariable rule, for, as shown by the Woods case, the injured man may use violent muscular action even when a bullet of large size has gone through the heart, and live three days. The wound in this case was through the right auricle. If the ventricles, one or both, are penetrated, it would be more probable to cause death sooner than where an auricle was injured; but the fact is established by more than one case that a bullet may wound the heart and the person live for some time, varying from hours to days.

Wounds of the Diaphragm.—When these are from gunshot or stabs, the organs lying either above or below are more or less involved, and death is due to the injuries beyond the diaphragm, its wound being comparatively unimportant. When, however, the wounding is a rupture of the muscle caused by contusions or falls, the condition is altered. Here the danger is from the complications that are apt to take place, for the torn muscle itself bleeds but little, and with as perfect rest as can be given would heal readily. The danger comes from what is known as phrenic hernia, as the passage through the opening made by the rupture of some portion of the abdominal contents is termed, and as the wound heals strangulation may supervene and be the cause of the death, even though over a year has elapsed since the receipt of the injury which caused the rupture. The history of the case would have to be carefully gone into by the medical examiner before he could give an opinion that the hernia was due to the injury under investigation.

Wounds to Abdominal Walls.—Blows struck on the abdomen do not usually show ecchymosis. While the yielding character of the abdominal walls allows of their escaping a good deal from the effects of a blow, the injury, nevertheless, may be most serious, for this very yielding allows the force of the blow to be expended on the deeper tissues or the contents of the abdominal cavity. The blow may be followed by peritonitis or by rupture of liver, spleen, stomach, or intestines; or it may be instantly fatal by shock, the concussion being to the solar plexus. In this case no trace post-mortem would be found, and the blow even could be a light one. Professor T. G. Thomas, of New York, used to relate a case where, in coming out of the theater, some young men were indulging in rather boisterous play, and one bending another quickly

over his arm, tapped him a sharp blow with the disengaged hand on the stretched abdomen. The blow alighted over the solar plexus, and, to the horror of him striking, his friend was immediately killed. In a fight, a blow may be seen struck and the recipient fall dead. If the medical examiner finds nothing on holding the autopsy to cause the sudden death, he can testify that a shock to the solar plexus will cause death, and the post-mortem examination give no evidence to support or disprove the statement. The absolute absence, however, of any other reason or injury to other organs will add weight to his testimony, evidence of the blow being present.

Wounds to the Liver.—The liver, by its position and structure, is peculiarly liable to suffer rupture from violence done to the abdomen. Or, like all the other organs, it may be injured by a fall. The contusion causing the rupture may not give external evidence of its infliction, and the patient after receiving the blow is able to walk and may complain of only pain and weakness. This condition is, however, only found when the rupture does not involve the large vessels, for if the vena cava is also torn, death is almost immediate. The rupture of the liver itself does not bleed rapidly, death following the injury in from one to two days, or it may be earlier. Cases are reported where the patient has lived longer, but the general rule is that death takes place within about forty-eight hours.

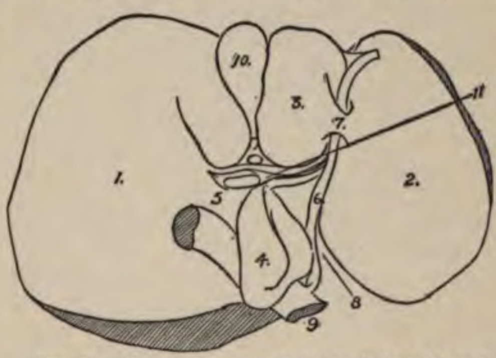


Fig. 73.—The liver: 1, right lobe; 2, left lobe; 3, lobus caudatus; 4, lobus Spigelii; 5, lobus caudatus; 6, longitudinal fissure; 7, pons hepatis; 8, fissure of the duct: 9, inferior vena cava; 10, gall-bladder; 11, transverse fissure. (After Taylor.)

The liver may be involved in other wounds, such as a stab either from above or below. If death is from the wound to the liver, and its large blood-vessels are not involved in the cutting, it follows much the same course as in rupture.

In the case of Mr. Hadley, the stab did not involve the liver, but the sharp end of the cartilage of the rib, becoming depressed and eroded by the action of the suppuration, caused the lesion of the liver, and the inflammation was only prevented from infecting the peritoneal cavity by the adhesions which had formed between the liver and parietes.

It has been seen in two cases quoted that gunshot wounds of the liver apparently had but small effect upon the wounded, and in neither case was the evidence post-mortem that death was due to the hepatic injuries. In both cases the wound was by pistol-ball, and in the case of Hess the man did not live long enough for any inflammation to start in the liver as the result of the bullet's passage. In the case of Woods, while he lived three days after the shooting, the hepatic wound showed merely the red line of the ball's track, and union was taking place. There was no evidence of bleeding having followed the bullet. Naturally, if a lacerating gunshot wound, such as would be made by a shotgun, was inflicted in

the liver, it would be fatal, and probably immediately so; but here the shock would be much greater than from a single ball, and this might have to do with the death before the wounding of the liver would have time to exert much influence. Again, such a wound would cause much greater hemorrhage than a pistol-bullet, and death might be due to this.

The spleen may be considered in the same way the liver has been, as affected by the same class of injuries, and causing death in the same manner. Both glands are so near alike in general character as regards injuries, that the description of wounds to one is equally applicable to wounds of the other.

Wounds to Kidneys.—Concussion may rupture these organs either to such an extent as to cause a fatal result, or slighter injuries ensue, from which recovery takes place. In 1889 a horse-car driver was violently thrown from his car by collision with a railroad engine. He was dazed by the fall, but after coming to his senses got on to another horse-car, went to his doctor's, walking a block after leaving the car, then went back in the same way to near the place where the accident occurred, and again leaving the car, walked to his home, about three blocks distant, and went to bed. He was assisted by two men when walking. That night and for three days afterward he passed bloody urine. After that time the blood gradually disappeared until it was entirely gone, about a week or ten days after the injury. There was undoubted rupture of a kidney in this case, for there was no injury to the bladder, no wounding which would cause bleeding, and in no other way could the blood in the urine be accounted for. And yet even with this ruptured kidney the man walked some distance. Cases are reported where persons suffering from ruptures which eventually caused death walked after the receipt of the injury, and gave at first no symptoms of such serious wounding.

Wounds of the Stomach and Intestines.—These organs may be ruptured from external violence in the same way as the foregoing, although ruptures from disease, from ulcers which have existed some time, are more common. The injury is one generally quickly fatal, and is characterized by shock and pain. The contents of the viscera escape into the peritoneal cavity, but usually there is little hemorrhage unless the rupture has involved a vessel. When the rupture is from disease, the microscope would aid in determining the fact, as it would show on some part of the rent the presence of the ulcer. And unless the body was found dead, or under such circumstances as to cause doubt of the manner of the death, the history of the case would answer the question of criminal interference.

Stab-wounds have the same effect as ruptured ones, with the added injury of the entering wound through the parietes. Death in such cases may be due to the shock and escape of the contents, or to these combined with bleeding. Even though a serious rupture may be present in the stomach, the patient may walk some distance and fatal collapse not ensue for some hours. This is also true of ruptures of the intestines. I am indebted to Dr. W. G. MacDonald, of Albany, for the following case: In 1893 a man of thirty-six years of age, strong and well, weighing about one hundred and forty pounds, a junk-dealer by occupation, engaged one Sunday morning in a wrestling bout with a friend who was a heavier man than himself, one weighing about two hundred pounds. They used what is called the "back hold," that is, each put his arms around the

other, the hands being clasped behind the adversary's back, and then each endeavored to throw the other by sudden side wrenches. While struggling and tugging the lighter of the two said, "Let go, I am hurt." He complained of pain in his right side, and sat down for a little while on a bench in his shop, where the wrestling took place. The pain did not lessen for some few minutes. Then, feeling a little easier, he started for his home, walking four blocks to the electric cars, in which he rode about half a mile, and then walked a block and a half to his home. The doctor was sent for, but did not see the patient until six o'clock in the evening, some three or four hours after the wrestling. When the physician arrived the man was sitting up. His pulse was fifty-four per minute, but no rise in temperature. Considering he had to deal with muscular strain, the doctor ordered morphine and hot-packs. Between two and three o'clock Monday morning the patient vomited, but no alarm was felt by the family until near seven o'clock, when symptoms of collapse appeared. The doctor was summoned, and in company with Dr. MacDonald, who had been called for consultation, he reached the house at nine, to find the patient was dead.

The autopsy showed no external lesion of any kind. All the organs were healthy, and no signs of disease were found. On opening the abdomen, extravasation of fæces stained with blood was found in the peritoneal cavity. No clots were seen. The whole peritoneum was congested, and freshly effused lymph was present. The intestines were matted together. The effusion was like that of hemorrhagic peritonitis. Fifteen inches above the ileo-cæcal valve, in the wall of the ileum, was a rupture five eighths of an inch long by three eighths wide, the long diameter being transverse to the gut. About one and a half inches below the rupture, nearer the caput coli, was an ecchymosis in the intestinal wall the size of a twenty-five cent piece. This ecchymotic effusion was in the muscular layer, and section showed it to be a fresh bruise. The intestines were very full of fæces. Careful examination of the rupture showed no sign of inflammatory process around the edge of the rupture, and nowhere in the intestinal track was there any point where an ulcer was beginning or had been.

The position of the rupture, the history of the case, and the fact that solitary ulcers of the small intestines do not occur, shows this case to have been a rupture from exertion, and, it may be, aided by strong pressure from the outside, for in the position the arms of the two men were in while wrestling, the forearm of his adversary would compress the abdominal parietes just about opposite the position of this rupture. And this outside pressure would not be light, but at the same time it would not be like the force of a blow, as it would be a squeeze or hug. Taking into consideration the full condition of the intestines, the pressure exerted from within by the diaphragm and from without by the arm of his adversary, the rupture was clearly due to the straining, and took place at the moment he called out, "Let me go, I am hurt." And notwithstanding the pain and the shock to the peritoneum of intestinal contents being poured out into it, the man walked five and a half blocks, rode in a street-car half a mile, sat up for an hour or more before the doctor saw him, and gave no symptom of being mortally hurt until two hours before his death.

On July 10, 1878, with suicidal intent, T. B., a prisoner in the Albany County Penitentiary, inflicted wounds upon himself with a knife he had

made out of the steel of a woman's gaiter, the blade being three eighths of an inch wide, two long, thick, pointed, and well ground. The case was reported by Dr. Samuel B. Ward, of Albany, who saw the patient with the penitentiary physician, Dr. H. R. Haskins. The man was serving a thirty years' sentence for counterfeiting, and at the time he attempted self-destruction was undoubtedly suffering from mental alienation. He did the cutting at night in his cell, and was not found until the morning. The doctor was sent for, and found the man exsanguinated, with no pulse at the left wrist and very little at the right. B. had made an attempt to sever the right carotid, had cut his abdomen and the left brachial about an inch above the elbow. The doctor found a wound one and a quarter inches long over the left brachial, but the artery was not in sight; a wound in the abdominal parietes which extended for seven inches, beginning a little to the left of the umbilicus and ending at the ensiform cartilage, through which protruded the stomach, large and small intestines, with omentum, gashed in several places, and fecal matter was on the skin, the viscera having been further cut after protrusion. The intestines were cold and dry, somewhat adherent, and had fuzz from the blanket which lay over the man sticking to them. Being apparently moribund, the parts were merely wiped dry with the handkerchief, and after an hour returned to the abdominal cavity, immediate efforts at reduction being prevented by severe hiccough and pain. The wound was closed by eight stitches, not through the peritoneum, and broad bands of adhesive plaster were passed around the trunk. The wounds in the neck and arm, bleeding having ceased, were brought together with plaster only. The man was kept under the influence of morphine, and after forty-eight hours was removed from his cell to the prison hospital. For four days he did not raise his head or move hand or foot. At the end of that time the stitches were removed, the wounds having nearly healed by first intention, about an inch of the abdominal wound being still open at top, but healed at the bottom. The pulse was always below a hundred, and the temperature never notably increased. Morphine was discontinued on the eleventh day, and the bowels moved voluntarily on the fourteenth day after the wounding. Dr. Ward states that by the 27th of the month a firm cylindrical mass could be felt where the left brachial was wounded, with pulsation in the artery two inches above and also at the left radial, as collateral circulation had been established. The prisoner was returned to duty November 1st.

About a year after this attempt B. made another, this time by cutting his throat. Dr. A. Vander Veer, of Albany, saw him, in consultation with the prison physician, Dr. W. H. Murray, and reported that the cutting had been done with very much the same sort of knife as was used in the first instance. This time, however, two knives were used, one in each hand, and the cutting done both ways. The trachea was completely severed, the œsophagus cut into, and severe hemorrhage was present from both superior thyroids, which the doctor ligated. The wound in the œsophagus was closed with fine silk stitches, that of the trachea with silver wire, the external wound carefully adapted, and good drainage secured. B. again recovered, and recovered not only from his wounds, but also his mental balance. He was pardoned by President Cleveland in 1887, and at that time was in excellent health, his former wounds giving him no trouble whatever.

This case is truly remarkable, and shows what a human being can stand without loss of life. It is, however, more than probable that it is one of those cases where "the exception proves the rule," for the injuries inflicted in either case would ninety-nine times out of a hundred be fatal. Still, it is just such cases that are most useful to the medical jurist, for he has to give opinions upon not only how wounds cause death, but whether they are the only and absolute cause; and cases like the above impress caution and the greatest of care in the post-mortem examination to see that nothing escapes notice which could in any way, even the slightest, have an effect upon the vital forces.

The injuries done the intestines were done after they had come out of the body. No mention is made of their extent, or whether any attempt was made to close their wounds. The man was so nearly dead and the wounding was so extensive that at the time he was seen the doctor considered there was no possible chance of his living, and it was only a question of time when he would die. Precautions were not taken, therefore, as to cleansing the intestines: these were merely wiped dry and returned to the cavity.

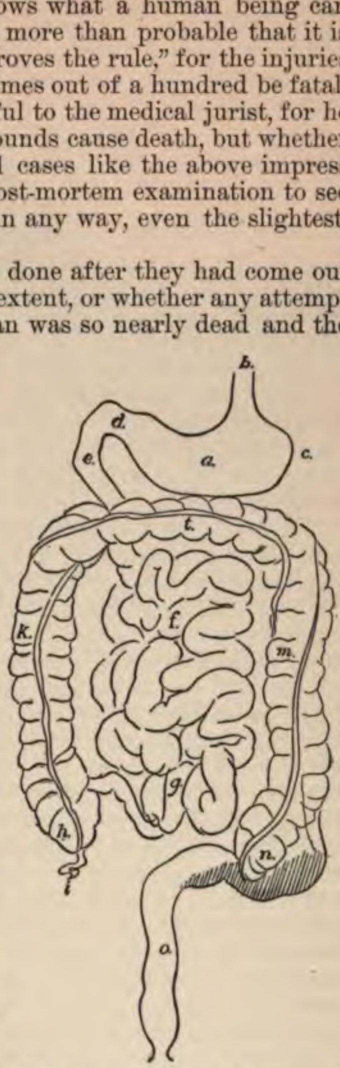


Fig. 74.—*a*, Stomach; *b*, œsophagus; *c*, cardiac end of stomach; *d*, pyloric end of stomach; *e*, pylorus; *f*, duodenum; *g*, jejunum; *h*, ileum; *i*, vermiform appendix; *k*, cæcum; *l*, *m*, *n*, ascending, transverse, and descending colon; *o*, rectum. (After Taylor.)

To compare this with the case of Dr. MacDonald's is to call attention to the great distance which lies between the cause of death in one man and the vitality and power of resistance to injuries in another.

Gunshot wounds of the intestines are usually fatal. Where the wounding involves the abdominal walls alone without puncture, if there is but little laceration no marked trouble may be expected; but if much loss of substance follow the injury, hernia may be a sequence, the cicatrix not being strong enough to control the viscera. From penetrating wounds the danger is hemorrhage, with escape of the intestinal contents, as in the case of Bedell, shot by Hess. If the large blood-vessels are cut by the ball, death would be rapid, and the bullet may lodge in the spinal column in such way as to cause injury to the cord and paralysis of all below the point of its contact. Balls have lodged in the abdominal cavity and the patient recovered without any bad effects. When the bullet passes in and out, traversing the large intestine, a false anus may result. Lieutenant Borie, of the navy, was severely wounded at the attack on Fort Fisher during the War of the Rebellion. The ball traversed the left side of the abdomen, cutting the descending colon. For three months and over he passed the fæces through the wound. Eventually recovering, he returned to duty. In December, 1867, I was returning

from Rio de Janeiro, and on the same ship Lieutenant Borie took passage, going home on sick leave. He had been attached to the South Atlantic squadron, but could not stand the effects of the hot weather, it seemingly affecting his old wound, causing paroxysms of pain which rendered him unfit for duty. His state-room being next to mine, I had full chance to observe his condition, and noticed how he suffered whenever the heat increased. As soon as we ran into cooler latitudes his condition improved. He stated that this had happened ever since his recovery, and while he felt no inconvenience from his wound when in cold climates, as soon as he was exposed to constant and high temperatures the pains came on, rendering him weak and absolutely unable to stand or walk.

Shot wounds of the smaller intestines are much more dangerous than those of the large, and the injury to the colon is less dangerous where it is to the descending than to the transverse or ascending portions. In the *Medical and Surgical History of the War of the Rebellion* but five cases of bullet wounds to the small intestines are reported as having recovered, and these are given with caution as to the fact that the intestines had really been implicated in the wounding. The medical examiner can, therefore, in making his statement as to the danger to life of a penetrating gunshot wound of the abdominal cavity, gauge somewhat the amount of danger by the probable course of the ball, and by knowing also the character of the weapon which fired the bullet.

Wounds of the Bladder.—This viscus may be injured in the same way as others, by blows, falls, incised or gunshot wounds. When the rupture is due to a blow, kick, or other contusion, it is usually fatal from peritonitis following the escape of the urine. These ruptures, from whatever cause, are most dangerous wounds, and the prognosis is necessarily unfavorable. If the extravasation does not pass into the peritoneal cavity, the chance of recovery is greater than in the contrary case, for the abscess consequent upon the presence of the urine in the tissues may be relieved by surgical interference. Should the diagnosis of rupture be made and of effusion of urine into the peritoneum, early laparotomy might increase the chance of recovery and certainly would be justified, for that the rupture would close spontaneously or that peritonitis would not be excited by the escaping urine are matters too conjectural to rely on, and surgical aid should be rendered, even though it carry with it an element of danger from the operation. While this is what the surgeon is called on to do, it may materially affect the case in court should the rupture be due to criminal violence, for the defense would justly question whether the death of the patient was not due to the operation and inflammation following it, rather than to the rupture whose production was charged to the prisoner. The surgeon, of course, cannot hesitate, his duty being to save life if possible; and the operation giving a chance greater to the patient than the almost positive condition which would follow the rupture, he should give the patient the benefit of that chance.

Rupture takes place when the bladder is more or less distended and when it is the result of blows no mark of injury or ecchymosis may be apparent. This is for the same reason as was noted where other viscera suffer rupture from contusion, the yielding parietes allowing the force to pass on inward. Bullet wounds are not as dangerous as incised or ruptured ones, and a fatal issue may not follow them by peritonitis until the wounds in the walls of the bladder slough. Out of one hundred and

eighty-three cases reported during the Civil War, eighty-seven cases of recovery took place, and no cases of rupture from blows or violence were reported at all. While the pain caused by all wounds of the bladder is severe, and in case of rupture with extravasation of urine the person experiences a sinking feeling, movements are not incompatible with the injury, and the wounded man may walk after its receipt. This fact prevents the defense from claiming absolute inability of motion on the part of the assailed as a proof that the rupture did not follow the assault.

Wounds of the Genitals.—In homicidal wounding by men, the genitals are not often if ever attacked, for the object of the assailant is easier gained by assaulting other parts. Accidental wounding from bullets, or even criminal wounding where the aim of the offender is poor, may take place. Kicks or blows, also, are reported as affecting these parts, but the generality of cases are in women. A severe blow on the vulva may cause laceration so sharply defined as to appear like an incised wound, and the danger is from hemorrhage, the parts being so very vascular. Unless in the insane, incised wounds of the genitals are indicative of homicidal intent, for accidental cutting is most rare, and the fact of a clean cut being found in the labia would be sufficient to arouse suspicion of an assault. Contusions or cuts made after death would be known by the fact of bleeding not having followed their infliction, for the autopsy would show the effect of profuse hemorrhage of other organs, and this condition would not be present if the laceration was made after death. A year or two since, in New Hampshire, a man named Almy killed a girl by putting the muzzle of a pistol into the vagina and firing a shot. He was seen to commit the deed, and the post-mortem examination confirmed the statement of the witnesses. He was convicted and executed. Here was a wounding of the genitals, but death was not due to it, for the ball penetrated further and caused immediate death by wounding the more vital organs.

Wounds may take place in this region by falls, but they are comparatively rare. The most frequent form of wound the medical jurist would meet with would be contusions and lacerations from kicks, and the evidence presented by the injury would decide against the probability of a fall being the author of it.

The uterus may also be wounded, and the injury prove fatal. The wounds produced by those performing criminal abortions have been fully treated in another portion of this work, and will, therefore, not be referred to further. Blows and kicks or falls on the gravid uterus may cause rupture, and the escape of the fœtus into the abdominal cavity. Death here would probably be due to the shock and hemorrhage, the autopsy revealing the condition. External marks may be absent, as is general in all this character of injuries, but the uterine walls may show ecchymosis in the same way the intestine did in the case reported by Dr. MacDonald.

The Relation of the Medical Witness in Matters other than Wounds.—It is contended by some that the medical man employed in a legal case should in no way take into consideration the bearing of any facts other than those purely pertaining to medical questions. I cannot agree to this view, for it is considered much would be lost which would be of great value to the proper administration of justice, if it was enforced. The doctor is more than a mere witness, for while he is called

as an expert on those subjects upon which he is supposed to have special knowledge, knowledge not possessed by laymen, and in this is an expert, experience shows he is more, for he is virtually the medical counsel. And it is no improper procedure for him to act in that capacity, for while he takes no part in the actual trial, in the examining and cross-questioning of the witnesses, and further has nothing to do with saying what course shall be followed in the management of the case, he must, in the very nature of things, counsel the lawyers how certain facts are the leading ones in the medical phase of the case, and why they are so. Before being able to act in this way, one in which there is not only no impropriety but also in which his absolute impartiality as an expert is not called in question, he must prepare himself to give an opinion which, to his mind, covers every medical feature, and to do this he must, or at least should, understand all the circumstances connected with the crime, that the bearing they have on the relations of the autopsy and the evidence of the wounds may be fully and justly weighed.

I have made it a rule to always investigate, personally, if it is possible, the place where the crime was committed. In the Mechanicsville case this led to finding another weapon than the one supposed, for the height of the ceiling prevented sufficient power being given to the piece of board claimed as the weapon, the assailed standing at the time of the attack. In the Woods case examination of the house resulted in finding a bullet in a window-sill, which further confirmed the evidence of the wounds, and proved the prisoner's statement to have been true. While it is not necessary before holding the autopsy to examine the *res gestæ*, after full and careful study of the body every item known to the attorney is of importance, and becomes more or less an aid to the forming of a true and just opinion of how the death was caused. The reason of the death is found in the post-mortem, generally speaking, or no cause may be revealed, in which case it is all the more important for the medical witness to hear all the circumstances known. In making a diagnosis of a case in private practice, the doctor asks many questions which appear to those hearing not only unnecessary but at times even impertinent. The family history is gone into as far back as it can be traced. The condition of collateral branches is asked about. The history of the patient himself is sought from the time he was in petticoats until the present, and then is added to the knowledge thus gained of hereditary influences or habits of life, the physical examination of the patient and the further inspection of the excreta. I believe it is just as obligatory upon the medical witness to study the legal case he is called to act in as carefully and fully before he gives his opinion as it is for him to do the same in the pursuit of his private business.

The theory of the defense in the Hess case was self-defense. And the evidence of the autopsy as detailed by Dr. Beach would not be inconsistent with the theory if the statements further made were exact, viz., that the shot was fired as Bedell broke from the men who were trying to hold him; for the line of the bullet as it traveled from the wound of entrance to the psoas muscle was such as would be made, and could probably only be made, the relative positions of both the assailant and assailed being taken into consideration, with the body bent forward. This is a fact for the medical witness to call attention to, for his special knowledge of the relation of the parts wounded in the normal position

when the body is erect, and the changes assumed by them when other forces, such as the pressure of the diaphragm and of the abdominal muscles, are exerted, would show to him clearly the position in which the man was when he was wounded, and thus the district attorney could be thoroughly informed of the entire bearing the evidence of the autopsy would have upon the case. Without the aid of the knowledge of the struggle, the medical examiner could only say the wound undoubtedly was received when the body was stooping, and he might or might not add, in violent muscular action.

The medical witness must of course be prepared to adduce the method of the crime from the evidence of the body alone, but while this could be the case and be done with reasonable certainty, doubt may be cleared and conjecture changed into fact if more understanding be had of the circumstances surrounding the crime. Woods had two other wounds besides the one which entered the chest and proved fatal. Both of these wounds were gunshot, both were from behind forward, but whether they were made by one shot or two was at the time of the autopsy undecided. The doctor engaged by the defense was present at the post-mortem examination. Together we discussed the evidence of these two wounds, and decided that they could have been made by one ball or by separate shots, for the right arm by being drawn backward, the forearm being flexed, could be brought into a position which would allow of a probe being passed through the wound in the arm and then to the grazing one in the side. Examination of the house showed, however, this bullet in the window-sill. If there were only two shots fired, this could not have been the bullet which made these slight wounds, for in no way could a man be placed for the ball to act on both arm and side and have it fired from the part of the room which Briggs stood in. If, however, it had made the wound in the arm, then it could be, for if the arm was wounded independently of the side, this shot could easily have made that particular wound. The direction of the bullet as given by its position in the window-sill was proof of its having been fired from where Briggs claimed he stood. And while the two lesser wounds could have been made by one ball, if it so happened that the arm was placed in a certain position, it was not a position the arm would naturally assume in one running, while if the ball found in the window did this wounding, the arm would be in precisely the extended position natural in one suddenly startled and who was fleeing for his life. Careful inquiry ascertained the fact that three shots had been fired. The autopsy, without endeavoring to place the limb in any particular position, gave the evidence that three shots had taken effect. Had the fact of three discharges not been known, the medical witnesses might have differed on how the wounds of arm and side were made, and the medical testimony been weakened by just so much in the minds of the jury.

In the Mallon case, examination of the place where the murder was committed showed by the evidence of the blood-stains in what position the body was when the shot was fired. While the jury did not convict, and despite all evidence turned the body around and placed it in such a position that the blood-stains would have had to go in the contrary direction to the force causing them, this was a deliberate act on its part and had nothing to do with the medical evidence. But without inspection and a knowledge of other circumstances in the possession of the district attorney, confusion on points of medical testimony would again have

arisen, and, judging from the value the jury attached to the medical evidence, might have succeeded in freeing the prisoner altogether instead of giving him the light penalty of manslaughter in the third degree.

In the case of Thompson, examination of the premises did not clear up the mystery of the death. If anything, it seemed rather to lead to the suspicion of homicide than to accidental death, for the absence of any point where such a wound and fracture as were found could be made by Thompson falling backward down the stairway gave color to the more probable cause of human agency; but sufficient circumstantial proof of an incontestable character could not be found to allow the physicians to state that the death was by murder.

For the medical witness to know all the facts, as far as may be possible, is not to bias his conclusions, but rather to help his arriving at just ones, and in this adding to the value of his testimony as well as to the value of his opinion on the medical bearings of the case. By neglect of this part of the work his testimony may not be thoroughly understood by court, counsel, or jury, and it adds another subject for counsel to try and make plain what should require no such effort.

The attention of the medical examiner to every point presented by the autopsy should be constantly borne in mind. Murders are not committed as a general rule in the presence of witnesses, and many devices are sought by homicides to cover their crime and make it appear the death was suicidal or accidental. The case of Mrs. Budge illustrates this point in a strong manner. Had the doctor who was called first known anything of medical jurisprudence, the chances are a miscarriage of justice would have been prevented. But the case shows he took no pains to even hold an autopsy. The throat was cut, a razor was found: plainly suicide. As to the evidence of the wound, the condition of the organs of the body, the question of disease or poison being present, the appearance of blood-stains, the appearance of the razor-blade, the position of the body—in short, any of the points a medical examiner should have constantly before him when summoned to such a case, he never stopped to look or reason about one of them. To stuff the throat with cotton to try and stop the bleeding, which, despite these efforts, continued, to sew up the wound and never ask why a corpse should bleed hours after death, was all he seemed capable of doing. In the case of the man killed at Fonda with a pistol-ball in the neck, the doctor failed to hold a complete autopsy, being satisfied with finding a cause of death. And this neglect on his part was turned to the advantage of the prisoner by his counsel, for death could have come from other causes, the wound not necessarily being a mortal one, and by the doctor's remissness no proof could be shown by the people that it did not. The autopsy on a body, where the cause of death is the subject of legal inquiry, is not a proper one unless every organ has been examined, every mark noted, every wound carefully inquired into, every morbid condition found inspected to see if death could have been produced by it; and the report made of the autopsy should show the cause of the death, and the only cause that it could come from. And where death is from a shock which would leave no positive signs on the dead body, the completeness and carefulness of the post-mortem examination would go a long way to showing that such cause alone could be held responsible for the death, and the proof of how that shock was brought about would be for the jury to consider. If no other

thought actuates the doctor to thoroughly perform this most important work, the fact that a man's life or liberty may be at stake should impress him with the responsibility he is assuming when he gives his opinion on the examination of the corpus delicti, on which opinion all may depend.

The evidence of wounds is most subtle, and care is needed that no point escapes the observer. At the best, the medical witness's testimony may be but the most probable and not the certainty; but the inspection he has made will enable him to decide upon the most probable, and not a number of possibilities. The autopsy is the most important part of the examiner's work, for from its reading his conclusion is first formed, to be strengthened by the attendant circumstances. The evidence of a wound, if clear and positive, is the strongest circumstantial evidence, for it points to the manner in which it was inflicted, it declares for the weapon, it shows the agency of another's hand, it proves the death was due to it, and tells its story in the most powerful manner an inanimate object can. Without careful study and a knowledge of the effects of wounds, a medical witness would misread the evidence, and be more than apt to give an opinion which further examination would show to be based on erroneous conclusions.

INORGANIC POISONS.

By C. E. PELLEW, E.M.

INTRODUCTION.

Definition of a Poison.—Before entering upon the main subject, it is proper to state what must be understood by the term "poison." As a rule this name is given to different substances which, when taken into the healthy human body in quantities not unusually large, produce, as a general result, injurious or even fatal effects. These effects are, as a rule, due to the chemical, not the mechanical, action of the substance, although it is not uncommon to include in the list broken glass, which in some parts of the world is not infrequently used as a slow, subtle, irritant poison.

It must be remembered, however, that almost all medicines when taken in excess will give poisonous symptoms, and, in like manner, many, if not most, of the commonest poisons are in general use, in small quantities, as medicines. Accordingly, the classification of any drug as a poison depends, after all, upon whether it has so far caused a sufficient number of dangerous or fatal results.

Again, a true poison will be active against the normal healthy body. In various diseases, perfectly harmless articles of diet may prove distinctly injurious and set up characteristic symptoms; while every now and then perfectly healthy people are met with who are affected by doses of common drugs, and by simple kinds of food. Thus the evil effects of sugar in diabetes, and of alcohol in genito-urinary diseases, are well-known even to the laity; while cases of idiosyncrasy have been frequently described, where a saucer of oatmeal or a single strawberry have produced poisonous symptoms.

The effects of a poison will vary very much according to the size and condition of the dose, the state of the system, the method of administration, and many other conditions. As a rule, though not quite invariably, it will produce injury no matter how it is introduced into the body, whether by the stomach, lungs, skin, mucous membranes, wounds, or any other way. Occasionally, however, a drug is met with, like curari, for instance, which is comparatively harmless when taken in the stomach, though exceedingly powerful when directly introduced into the blood.

The effects of the various poisons differ greatly among one another. Many of the mineral poisons here dealt with have a distinctly irritating, if not corrosive, effect upon the tissues with which they are brought in contact. As good examples of these we may mention the fixed alkalies and the mineral acids.

In most cases, however, besides the local effects of the poison, there are other specific effects produced in various parts of the system by the poison, after it has been absorbed into the circulation. These may be inflammatory changes in various organs, the liver, kidneys, heart, etc., as from phosphorus; or in the stomach and intestines, as, for instance, in ordinary cases of arsenic poisoning; or a distinct paralysis, partial or complete, of the great centers in the medulla, as in poisoning by bromides, by large and soluble doses of arsenic, by ammonia and nitric acid vapor, and the like; or a slower and gradual paralysis of the peripheral nerves, as in chronic lead and arsenic cases; or some direct change produced in the blood, as by potassic chlorate and carbonic oxide. Besides these there may be marked disturbances of the brain and spinal cord, principally produced by the alkaloids and kindred principles.

To properly classify the mineral poisons according to their effects would be a difficult and complicated task. Hence, in the following pages they are taken up, one after the other, in a rough and simple classification, somewhat according to their physical and chemical properties. The first section will treat of the alkalies; then will come the acids, the halogens and haloid salts, and phosphorus. Next I shall discuss the metallic poisons, beginning with antimony, arsenic, lead, mercury, and copper. And I shall close my treatise with a few words on the metals of less importance.

I. THE ALKALIES AND THEIR SALTS.

The term "alkali" is applied to a substance possessing certain properties. It will dissolve in water, will neutralize acids, will turn red litmus-paper blue, will saponify soaps, will have a "soapy" taste, and, when strong, will corrode many organic substances, including the skin and many of the tissues.

These properties are possessed by the hydrates, carbonates, and phosphates of the common alkaline metals, sodium, potassium, and ammonium, and also of the rarer metals lithium, cæsium, and rubidium. They are possessed by the hydrates of the alkaline-earthy metals, calcium, magnesium, barium, and strontium, but only to a slight extent.

The most powerful of these compounds are the caustic or hydrated alkalies, i.e., the hydrates of sodium, potassium, and ammonium. The carbonated alkalies, i.e., the carbonates of these same metals, while less active than the former, can still, especially when impure, act as powerful corrosives when taken internally. The bicarbonates, however, of soda and potash are so mild that their solutions can be applied in large quantities, as antidotes to acids, not only upon the skin, but also internally, and upon delicate surfaces such as the face and eyes.

Soda and Potash.

These compounds, which are practically similar in their reactions and effects, are met with, as a rule, in the form of sodium and potassium carbonates mixed with some of the caustic alkali.

They are in common use, both in the arts and in the household, for the manufacture of soap, and the preparation of other sodium and potas-

sium compounds. And yet cases of poisoning by their means are extremely rare, and usually are the result of accident.

Symptoms.—When the solutions are concentrated the victim feels at once an acrid, burning taste, which is usually enough to make him try and spit the liquid out, and to wash out his mouth as well as he can. If the solution is actually swallowed, there is a burning sensation in the throat, reaching down to the stomach. This is usually followed by intense pain, and by vomiting, first of mucus and then of blood. The lips, tongue, and pharynx become swollen, raw, and inflamed; the voice becomes husky, and there is much difficulty in swallowing.

This is generally accompanied by symptoms of severe shock. The skin becomes cold and clammy, the pulse feeble, and the patient becomes extremely weak and exhausted, sinking often into a comatose state. Death may result from this in the course of a few hours, but the patient often recovers from this only to suffer from stricture of the œsophagus and consequent inability to swallow food, or from ulcerations of the stomach, or stricture of the duodenum, which prevent the food from being digested. In either of these cases the patient may linger on for weeks, months, or even years, only to die a miserable death from starvation.

An example of this is given by Dr. Hadden (*Trans. London Pathol. Soc.*, 1890, vol. xli., p. 86), where a stoker on board ship swallowed, for suicidal purposes, several ounces of caustic potash. When seen a few days after, his mouth and pharynx were much swollen and charred, and the patient was suffering greatly. At the end of a week a cast of the œsophagus was found protruding from his mouth, and when carefully removed it proved to consist of the mucous and submucous coats of the whole œsophagus and the larynx, carrying with it some of the circular muscular fibers.

The patient lingered for some time, but constriction began to take place, and more and more difficulty was experienced in swallowing, until the poor fellow finally died at the end of three months.

Post-mortem Appearance.—When death has occurred in a few days, the mouth, œsophagus, and stomach will all show extensive signs of corrosion. The mucous membranes will be much abraded and bloody, and the exposed surfaces raw, and often colored yellow or brown.

When the patient has died from the secondary effects of the poison, the mouth and upper part of the throat may have healed, but signs of ulceration or of thickening and constriction will be noticed in the œsophagus and stomach, or in the small intestine.

Fatal Dose.—The smallest fatal dose on record is given by Taylor in the case of a young lady, who died seven weeks after taking one and a half ounces of the common potash solution of the shops, containing some thirty or thirty-five grains of caustic alkali. In other cases death has been reported from half an ounce or so of the dry poison.

Time of Death.—Taylor mentions a case of a boy dying in three hours after drinking the poison, and other cases are on record where death occurred, from shock, within twenty-four hours. The patient, however, may linger for a long time, two or three cases being known where death occurred after two years, and one case, quoted by Wormley from Sir C. Bell, where the patient died after twenty years.

Treatment.—Where the poison has been swallowed for some minutes antidotes will have but little effect. The alkali should be neutralized as

far as possible with diluted vinegar, or weak organic acids, or by lemon, lime, or orange juice. Some good can also be done by giving milk, barley-water, solutions of albumen or gum, and the like, and also by giving olive-oil in some quantities, to soothe the inflamed surfaces, and also, perhaps, to saponify any free alkali remaining. It is dangerous to use the stomach-pump where the œsophagus is likely to be so corroded, for fear of perforation.

Chemical Analysis.—The presence of alkalies can be best told by the soapy taste and the reaction with litmus or other test-paper. The carbonated alkalies can be distinguished from the caustic by effervescing with acids, and from the bicarbonates by at once giving a white precipitate with magnesic sulphate.

To distinguish potash from soda we can use four different tests:

(*a*) A moderately strong solution of potash or its salts is precipitated by a solution of platinic chloride, forming yellow octahedral crystals of potassic platinic chloride. A precisely similar compound is produced by solutions of ammonia, so, if the latter be present, it must be removed by boiling with calcic hydrate, or by evaporating to dryness and igniting at a dull red heat, before making the test.

(*b*) If a rather strong solution of potash or its salts is added to a strong solution of tartaric acid, or, better, of acid sodic tartrate formed by adding a little soda to the acid, it will form a white crystalline precipitate of cream of tartar. This is soluble in free mineral acids, and also in the free alkalies.

(*c*) When alkali solutions are carefully neutralized with dilute nitric acid and then allowed to crystallize on glass slides, the potassium nitrate will form long, slender, fluted prisms. The sodium nitrate, however, crystallizes in rhombic plates.

(*d*) When a drop of alkali solution upon a platinum wire is heated in a Bunsen flame the yellow flame of sodium will always be present. If, however, we place in front of the flame a piece of cobalt blue glass, it is possible, if potash is present, to distinguish its characteristic violet flame. It is more accurate, however, to make this test before a spectroscope, and to recognize the potassium by its two lines, one red and the other blue.

Ammonia.

The alkaline salts of ammonium differ from those of potassium and sodium by being volatile and temporary. Caustic ammonia, or ammonium hydrate, is simply a solution of the ammonia gas (NH_3) in water, and on heating or evaporation the gas disappears, and with it the alkaline properties. Ammonium carbonate is a solid which dissolves freely in water, but this too is volatile in the air, when dry, at ordinary temperatures, and is readily driven from its solution by heat.

Accordingly, in poisoning by ammonia the patient, if he survives a short time, is more apt to recover and escape permanent injury than in the case of soda and potash. But, on the other hand, the gas itself is poisonous, and liable to cause death suddenly, when inhaled, not only from its caustic effect upon the air-passages and lungs, but also from its action on the central nervous system, causing, when concentrated, a paralysis of circulation and respiration.

Caustic Effects.—Cases are not infrequent where persons, usually while intoxicated, have swallowed small or large doses of aqua ammonia, and suffered from the usual symptoms of caustic alkali. Thus (*France Méd.*, 1879, p. 65) a case is reported where a few drops of ammonia were taken by mistake, and almost immediately spit out. There resulted purely local lesions in the mouth and throat, which became, in a day or two, very deep and very painful, but healed up in eight or ten days.

In another case (*Boston Med. and Surg. Jour.*, 1891, vol. cxxv., p. 677), a man, aged forty-six, swallowed a gulp of household ammonia. He spit it out at once, and took diluted vinegar and then milk. In two hours' time his lips, gum, tongue, and tonsils were swollen, raw, and much inflamed. His voice was husky, his respiration slow, but he had no vomiting. He was treated with cold compresses around the neck, and oil, milk, etc., internally. The second night he developed symptoms of Bright's disease, i.e., albumen, casts, blood, and pus-cells in the urine, which was very scanty, and some headache and delirium. But when treated with digitalis his kidneys recovered, and the local lesions healed and the man was well in eight or ten days.

In another case (*Lancet*, 1890, part ii., p. 1214), a man who had taken a mixture of ammonia, turpentine, and oil, while drunk, suffered so badly from dyspnœa in an hour and a half after taking the poison that the surgeon, to save his life, performed tracheotomy. In spite of rather grave kidney and lung trouble the man slowly recovered, and was quite well in less than a fortnight.

Severer cases, ending in death, and showing symptoms very similar to those of rapid soda or potash poisoning, can be found occasionally in the books or in the journals. Thus, Dr. Garvin (*Boston Med. and Surg. Jour.*, 1880, vol. ciii., p. 166) gives an interesting case of a man, when tipsy, who took some four tablespoonfuls of aqua ammonia, remarking at the time that it smelt pretty strong. Some of this dose reached the stomach, for he vomited at once, and complained of burning, not only in his mouth, but down his throat and in his stomach. He died in four days and a quarter. A similar case is given in the *Canada Med. and Surg. Jour.*, vol. x., p. 449. Taylor gives several instances of this sort. Among others he quotes from Dr. Barclay a case of a girl who died, three months after taking some ammonium carbonate, from contraction of the œsophagus and irritation of the stomach.

Cerebral Effects of Ammonia.—Besides, however, acting solely as a caustic, cases are met with where death occurs very rapidly, and long before the inflammation could have produced fatal results. This occurs sometimes when taken in solution. Thus two or three cases are quoted by Taylor where death occurred within a few minutes after drinking some ammonic hydrate.

But usually these cases result from smelling and inhaling the gas. Thus a case is mentioned by Routier (*France Méd.*, 1879, p. 65) where a doctor, in an epileptic fit, was given strong ammonia to inhale, and immediately fell in a syncope and died.

A very interesting report is given by Dr. Fairbrother (*St. Louis Med. and Surg. Jour.*, 1887, vol. lii., p. 272), where three men lost their lives and a fourth was permanently injured by an accident when setting up an ammonia ice-machine. They were exposed to the gas for some three minutes. One when dragged out was comatose and unconscious, and

died in fifteen minutes. Another was suffering as though from chloroform in the stage of excitement—i.e., he was unconscious, in wild delirium, and could not stand. He was not improved by the injection of half a grain of morphine sulphate, and died suddenly in two hours. The third was entirely conscious and walked home. He could swallow readily and talk easily, but complained of occasional difficult breathing, and after five hours' time, in a sudden attack of dyspnœa, he gave two or three gasps and died. The last suffered from bronchial irritation for some months. His leg was broken by the fall and had to be amputated, and he became partially paralyzed on one side.

Analysis.—Ammonia and its compounds can be readily recognized by their being volatile, and by their giving off ammonia gas when heated, either by themselves or with calcium hydrate (lime-water). The ammonia gas not only has its characteristic odor, but will also turn blue a wet piece of red litmus-paper exposed to it, and will give white fumes in the presence of a rod dipped in hydrochloric acid.

II. THE MINERAL ACIDS.

Sulphuric, Hydrochloric, and Nitric Acids. Also Chromic and Boracic Acids.

These compounds in many respects are the reverse of the alkalies, just mentioned. They have a sour taste, turn blue litmus-paper red and most vegetable dyestuffs either red or yellow, neutralize alkalies, and dissolve most metals, liberating hydrogen or some other gas. Upon organic matter and upon the tissues of the body the strong mineral acids act even more violently than the alkalies, corroding rapidly and fiercely any part of the body with which they come in contact.

Sulphuric Acid—Oil of Vitriol—H_2SO_4.

This substance was known to the alchemists, and has been an article of commerce since the middle ages, under the common name of oil of vitriol. When concentrated it is a heavy, oily liquid, usually with a yellowish or brown color, and no smell. It combines very readily with water, dissolving in it with the formation of considerable heat, and extracting it from the air and from organic compounds. It is intensely corrosive, charring organic compounds and destroying their substance. It is, of course, less active the more it is diluted.

Sulphuric acid, in common with the other mineral acids, is not often used for murder, the taste betraying the attempt to the victim, and the symptoms of death from it being characteristic. Cases, however, have been occasionally reported where it has been purposely administered to children, and also to intoxicated adults, with fatal results.

It is not uncommonly used for suicide, especially among the lower classes on the Continent. For instance, in Berlin it is the commonest of all poisons, in some recent years averaging forty percent. and over of all the poisoning cases taken in the general hospitals, while phosphorus came second, with some twenty percent., and oxalic acid next, with some eight percent. In that city the cases seem most common among the

servant-girls, who on comparatively slight cause become inclined to suicide, and take the first and readiest means to attain their end. In other parts of Germany these cases are less common, and in France and England they average only six or eight percent. of the casualties from poison.

Some seventy-five percent. of all the cases are of women, who, as yet, do not seem to have found out that, of all the poisons known, this is the most painful in its effects.

Cases of accidental poisoning are also occasionally met with, frequently in children; while the strong acid is not infrequently used for throwing upon the face and hands of rivals or enemies. This pleasant practice is also largely confined to the gentler sex, and often results in terrible and permanent disfigurement, and sometimes in very serious injury to the health.

Symptoms.—These are, in general, the same as those of the strong alkalies. There is great pain in the mouth, throat, œsophagus, and stomach, if the acid penetrates as far. The interior of the mouth, if it can be seen, is greatly inflamed, swollen, and covered with a white lining. The tongue, in bad cases, is terribly swollen, often projecting out of the mouth, and is gray in color, while the salivation is profuse.

After a short length of time come the evidences of collapse, sunken eyes, pallid face, cold and clammy skin, impaired circulation, and labored breathing. There is great thirst, which cannot well be satisfied, and choking, retching, and vomiting, often of much blood. Generally the patients are rolling around in agony on the bed, but at other times, even quite rapidly, they fall into a semi-unconscious state, and lie in a state of stupor.

Death, under these circumstances, may occur in a few hours, or, more often, in one or two days, either from collapse or from perforation of the stomach. It may also occur, sometimes very rapidly indeed, from the effect upon the air-passages, even when no acid has been actually swallowed. In other cases, when the patients recover from the immediate effects of the poison they often die in the course of some weeks or months from the secondary effects of the poison, such as strictures of the œsophagus or stomach, or from perforation of the œsophagus. According to Litten (*Berlin Klin. Wochensch.*, 1881, p. 616), in the Berlin hospitals some thirty-nine percent. die while in the hospitals, and some thirty percent. more from the after-effects.

Treatment.—If taken at once the acid may be more or less neutralized with bicarbonate of soda, or magnesia, taken in good quantities with large amounts of water. If these cannot be obtained, plaster from the walls of rooms may be of some service. The stomach-pump must not be used, for fear of perforation; but after the acid has been neutralized, and before, if possible, swallowing has become too difficult, albumen, milk, and mucilaginous fluids of all sorts should be taken into the stomach, and the mouth and throat covered with vaseline and the like.

The collapse and other symptoms must be treated as they come. An interesting case, where life was saved by a little forethought, is reported in the *Glasgow Med. Jour.* (1879, vol. xii., p. 390). A child, thirteen months old, while playing, swallowed a few drops of concentrated sulphuric acid, and fell on the floor in great distress. A local doctor was called in, and gave emetics, causing the child to vomit some dark-colored

liquid. Later a prominent physician was summoned, and found the child suffering greatly from acute laryngitis, with breathing much affected He sent the baby around at once to the hospital, with a note to his house-surgeon there to be ready to perform tracheotomy if necessary. Soon afterward the child got worse, but was relieved at once by tracheotomy, and recovered completely in five weeks' time. The acid never reached the œsophagus, for the child swallowed food all right the next day.

Post-mortem Examination.—This mainly shows the evidences of acute inflammation and corrosion upon all portions of the body touched by the acid. When the action is rapid and the acid strong, the contents of the stomach, any effused blood, and even the walls of the œsophagus and stomach, will generally show marks of charring, this acid having the peculiar property of browning or blackening most kinds of organic matter. The skin also, where any acid has fallen on it, will be much corroded, and sometimes blackened.

Tests.—In like manner it is generally possible to trace this poison, in fresh cases, by noticing the black and burned appearance of any spots upon the clothes, linen, or other material touched by the acid or by the first vomited matter. The regular test for sulphuric acid is by means of a solution of barium chloride, acidified with hydrochloric acid, which gives a white, insoluble precipitate of barium sulphate.

To extract the free sulphuric acid from the tissues, it is best to soak them thoroughly, finely divided, in a little water, and to evaporate this extract to dryness. It is taken up with a mixture of alcohol and ether in equal proportions, which dissolves free sulphuric acid and also free phosphoric acid, if present, but not their salts, nor free hydrochloric or butyric acids. This liquid can then be tested by barium chloride.

From experiments made by Garnier (*Ann. d' Hyg.*, 1884, vol. xi., p. 227, and 1887, vol. xvii., p. 148) it would appear that free sulphuric acid is rarely found in the tissues, but that it liberates free phosphoric acid instead. And hence, that the presence of the latter, proved by obtaining a yellow precipitate on adding ammonium molybdate to the alcohol and ether extract, is a satisfactory indication of the action of the more powerful acid.

External Application of the Acid.—It is well known that the concentrated acid, oil of vitriol, acts with great violence upon the skin and flesh, and not infrequently most serious injuries result from the acid being thrown, either from malice or by accident, upon the face and skin. In all those cases great suffering and permanent disfigurement can hardly be avoided excepting by prompt treatment by the victim or bystanders. It so happens that sulphuric acid does not act instantaneously; so, if directly the acid strikes the skin the injured parts are washed with a good stream of water, and then any residual acid neutralized with sodic bicarbonate, no harm will be done. If water is not at once obtainable, the acid may be largely removed by wiping it off thoroughly with handkerchiefs and cloths, and then, even if the rest is not washed off for some few minutes, the results will not be serious. These points should be particularly impressed on students in chemical laboratories. A few years ago a School of Mines student, by carelessness, exploded a flask of hot, concentrated sulphuric acid, getting the liquid all over his face and hands, and some even into his eyes. The man himself rushed toward the sink;

his friends ran to help him, and while some turned on the water and washed the acid off, two others carried over the sodic bicarbonate bottle and deluged his face and his eyes with it, pulling the eyelids open for the purpose. The man was out of college for three or four weeks, but then returned with perfect eyesight, and with hardly a perceptible scar on his face.

A somewhat similar accident with cold acid occurred in another well-known laboratory a few years ago, and was the basis of a lawsuit. The student was frightfully burned on one side of his face, losing part of his nose and the sight of one eye, and it was claimed that no treatment was given in the laboratory, but that the lad was taken first to one doctor some blocks away, and then to another, the latter finally applying some oil.

Hydrochloric Acid—Muriatic Acid—HCl.

True hydrochloric acid is an acid, irritating gas, extremely soluble in water. The acid of commerce is a colorless or yellowish liquid, with a specific gravity of 1.15 to 1.20, and contains some thirty-five or forty percent. of the gas dissolved in water. It has a strong, irritating smell and acid taste, and produces white fumes when exposed to vapors of ammonia.

It is but rarely taken as a poison, and then almost invariably from accident or for suicide. Its symptoms are very much like those of sulphuric acid, or of the caustic alkalies described before, i.e., intense inflammation of mouth, œsophagus, and stomach, followed by collapse, and, if these primary symptoms are not fatal, by secondary symptoms of stricture of œsophagus or duodenum.

As in the other cases, the time of death is very variable. Most of the acute cases reported have died in one or two days, although Wormley quotes a case of death in fifteen hours, and an interesting case, dying in seventeen hours, is given in the *Lancet* (1884, part i., p. 65). In the latter case death resulted from collapse, and, on autopsy, there were found perforations of œsophagus, stomach, and duodenum. The mucous surface of the mouth was white. Blyth (*Poisons: Their Effects and Detection*) quotes a case of death in two hours.

Some interesting cases of death from secondary symptoms have been recorded of late years (*Lancet*, 1890, part i., p. 797; *New Zealand Med. Jour.*, vol. ii., 1889, p. 241; and others). In the first of these the patient drank by mistake an ounce or two of strong acid. He had severe inflammation of the stomach, which healed up satisfactorily in twenty or twenty-five days, and in ten days more he was dismissed as well. But two months after this cure he returned to the hospital to be treated for intestinal trouble. His stomach was opened, in the hopes of dilating the stricture of the pylorus or duodenum, which seemed to be present; but the mucous membrane of the pylorus was so thickened, and adhered so closely to that of the stomach, and there were so many cicatrices in the latter, that the surgeon could not find the pylorus at all, and the patient died in a few days. It was found afterward that the pylorus was completely closed.

In the New Zealand case death occurred after four months from stricture of the duodenum just below the pylorus.

The fatal dose, as with sulphuric acid, depends more upon its strength, and upon whether it has actually reached the stomach, than upon its quantity. Cases of death have been reported from one or two teaspoonfuls of concentrated acid.

Distinction from Other Acids.—Hydrochloric acid, in distinction to sulphuric and nitric acid, does not leave any particular stain or scar upon the surface of the skin, although, when concentrated and allowed to stand, it will set up inflammation. It does not char organic substances, like sulphuric acid, nor does it turn woolen goods or hair or epidermis yellow, as does nitric acid. It is more volatile than the other acids, and after a day or two cannot be detected in dry stains.

The test for hydrochloric acid, as well as for common salt and other metallic chlorides, is the formation of argentic chloride, a white curdy precipitate soluble in ammonic hydrate, by the addition of a solution of argentic nitrate acidified with nitric acid. In making this test upon any extracts of tissues or of the contents of a stomach, it is important to remember that all the tissues contain sodium chloride, and that the gastric juice, during digestion, contains about 0.2 percent. of free hydrochloric acid.

It has been proposed, to see if the hydrochloric acid in an extract is free or combined, to divide it into two parts, to add a little excess of sodic carbonate to the one, and to evaporate both to dryness. Any uncombined acid will thus be driven off, and if, on testing with acid argentic nitrate, the one with sodic carbonate shows more chlorides than the other, the excess must have been due to free acid.

Nitric Acid—Aqua Fortis—HNO_3.

This substance, as found in commerce, is a colorless or yellow corrosive liquid, with a specific gravity of about 1.40. It acts on organic substances more rapidly, and quite as violently, as sulphuric acid, but by oxidizing them, whereas sulphuric acid deprives them of water and chars them.

It has been used for poisoning for some four hundred years, and yet but few cases are reported. When cases do occur they are very similar to those from other corrosive poisons, although occasionally accompanied with less pain. It can, however, be at once distinguished from the other acids by producing yellow, and finally brown, stains upon any tissues, or indeed, any substances of animal origin, with which it comes in contact.

Death from this poison may result very rapidly, especially with children. Thus Taylor mentions a case where a child, intentionally poisoned, died in a few minutes, and another case, of an adult, in an hour and three quarters. Usually death takes place within twenty-four hours, although occasionally it is delayed for some weeks or months, until the usual secondary symptoms are developed.

The fatal dose of this poison is probably smaller than of the other mineral acids, and is generally given as about one quarter of an ounce, an amount which has been known to kill in two or three instances.

Treatment is usually unsuccessful, but is conducted on the same principles as in the case of sulphuric acid.

Poisoning by Nitric Acid Fumes.—When large surfaces of the acid are exposed to the air, the resulting fumes, partly of the acid itself and partly of some of the lower oxides of nitrogen, are extremely poisonous. Three or four instances of fatal accidents from this cause are reported in the journals, and quoted by the standard authorities. In almost every case they happened to chemists or druggists, and their assistants, who were endeavoring to clean up the *débris* after breaking a jar or carboy of nitric acid.

The symptoms generally come on after some little time, and then develop more or less rapidly into acute inflammation of the air-passages, which may prove fatal.

An interesting case of this class of poisoning is given by Dr. Temple (*Boston Med. and Surg. Jour.*, 1884, vol. cx., p. 496), where, out of four persons who tried to get a broken carboy of acid out of a store, one died and the rest were more or less affected. One of these was a gentleman who was exposed to the fumes but a few minutes, and was taken down with a moderately severe attack of pneumonia in a few days.

Another, a healthy assistant, felt suffocated, and found that he was relieved by going into the open air to breathe. This lasted, off and on, for thirty-five minutes. In about three hours he felt a constriction at the chest, and pain on inspiration; he had a cough, and his face was pale, almost of a lemon color. His pain and cough increased during the night, and next day he was worse. The third day he had a slight cough and some pain on inspiration, and felt very weak. There were a few moist râles over the chest. After that he got better, and was quite well by the end of the week.

The third was exposed in the same manner as the one just mentioned, but escaped with a severe cold for two weeks.

The last was the proprietor of the shop, a healthy man of about fifty-four years, who had a longer exposure to the fumes. Four hours later he complained of "not feeling right," and took a car to his brother's house. In an hour and a half more he felt worse, with a cough, and pain on deep inspiration, and called a doctor. His pulse was rapid and weak, his respiration fast and shallow. The doctor prescribed ten grains of ammonium carbonate, which relieved him, and he went home feeling weak, and with a dragging step.

During the night he coughed incessantly, bringing up frothy, straw-yellow mucus. In the morning he felt easier, and took some milk, and in the afternoon he was free from pain, excepting a tightness around the chest. But later his pulse became very feeble, and in his chest were many coarse râles, and before night he died, about thirty hours after the accident. At the autopsy his lungs were œdematous, with slight injection of the bronchi, and more of the mucous membranes of the trachea and larynx. His heart and liver were injected, and there were small ecchymoses in the right auricle of the heart.

Chromic Acid—Chromic Anhydride—CrO_3.

This compound, which crystallizes in deliquescent crimson prisms, and is extremely soluble in both water and alcohol, is frequently used in medicine as a cautery. It gives but little pain, and destroys rapidly and

deeply, and hence is often employed as a substitute for electro-cautery in removing vegetations, extirpating tonsils, and the like.

Most of the text-books on materia medica and therapeutics recommend it highly, and give no mention of any dangers from its free use; but of late years a few cases have been reported which make it worth while to speak of it here.

For instance, Dr. Fowler (*Brit. Med. Jour.*, 1889, part i., p. 1113) was cauterizing the tonsils of an emotional woman, forty-five years old, with the acid. The patient, in spite of instructions, swallowed her saliva with a drop or two of acid in it, and noticed a slight burning in her throat. In half an hour she had violent pain in the epigastrium, with severe and agonizing vomiting of a green ropy fluid, and fell into a state of collapse. Purging came on in about an hour. She was treated with stimulants, hot-water bottles, and the like, and recovered in about three hours, having after recovery an abundant flow of urine.

A similar case is reported by Tisné, in the *Jour. de Med.*, Paris, 1887.

The acid can also act violently when used externally. Thus, Dr. White (*Univ. Med. Mag.*, Phila., 1889, vol. ii., p. 54) gives a very interesting and straightforward account of the death of a patient of his in twenty-seven hours, after removing some vegetation from her genital organs by a strong solution of chromic acid. The patient, after recovering from the ether, complained of pain in the vulva, and died in a state of collapse. The liver and kidneys, on autopsy, were found congested, and on analysis contained chromium.

In other words, not only is chromic acid a powerful corrosive, but it probably has some direct action on the central nervous system when taken into the blood.

It is worth noticing that potassic dichromate, $K_2Cr_2O_7$, an orange-red salt in common use in the arts, also has very decided toxic properties, partly local, but principally affecting the nervous system, and that a few cases of poisoning have been reported from its use.

Boracic Acid—Boric Acid—H_3BO_3.

Boracic acid occurs in commerce as white or colorless crystals, easily soluble in hot, and moderately in cold, water. It has a slight acid taste and reaction, but is non-irritant, has no odor, and is much used as a mild antiseptic, not, it is believed, actually killing the germs, but preventing their further growth.

Some few cases have of late years been reported which tend to show that when absorbed by the body in moderately large quantities it may act as a vigorous poison. Thus in the *Med. News* (1882, vol. xl., p. 571) are quoted two cases where death occurred from washing, with five-per-cent. solutions, in one case a large abscess and in the other a pleural cavity. And cases of poisoning, with recovery, are given in the *N. W. Lancet* (1888, p. 22), and by Dr. Welch (*Med. Record*, 1888, vol. xxxiv., p. 533) and Dr. Lemoine (*Gazette Méd.*, Paris, 1890, p. 205). The latter, who gives four cases of poisoning by surgical dressings of the acid, explains them by the fact that the patients all had kidney trouble, which allowed the drug to accumulate.

The symptoms were much the same in most of the cases. There was

a general rash, beginning near the place of application, resulting often in exfoliation. There was loss of appetite, nausea, and vomiting; there was often more or less trouble with the intellect, great depression, melancholia, insomnia, hallucinations, and even delirium; and in the worst cases there was collapse.

III. THE HALOGENS AND THEIR SALTS.

Under the above name we include four elements, chlorine, bromine, iodine, and fluorine, whose sodium and potassium compounds closely resemble sea salt, sodium chloride. These substances all combine with one atom of hydrogen to form acids, and their compounds with oxygen and with various metals resemble each other greatly. They differ from other elements in having colored vapors, which, by the way, are all intensely irritating to the lungs.

Chlorine—Cl.

This substance, a heavy, greenish-yellow, corrosive gas, is manufactured in large quantities for bleaching and antiseptic purposes. It is very corrosive, and, in any quantity, will set up acute inflammation of the air-passages. Inhaled in large amounts it produces narcotism, and even death, by paralysis of the nerve-centers; but although in every qualitative laboratory some student or another always gets a violent spell of coughing, from smelling too eagerly at the gas as it is evolved, cases of serious poisoning are rare. In fact, one of the few cases on record has just occurred (February, 1894) in Ithaca, where, in a foolish attempt of some college boys to break up a rival class supper by injecting chlorine gas into the room, one person in feeble health was killed, and several others severely affected. Its salts are not poisonous, unless in enormous doses, with the following exception:

Potassic Chlorate.—This salt occurs in the form of colorless flat crystals, with a bitter, salty taste, readily soluble in water. It is largely manufactured for oxidizing purposes, for use in explosives, and for producing oxygen.

Externally it is a powerful irritant upon mucous membranes and ulcerated surfaces, and is used largely for gargling and washing the mouth in sore throat, salivation, small ulcers, and the like, and also for treating other inflamed surfaces.

Internally it is a decided poison, and though often swallowed rather freely in the above disorders, is, in large doses, always to be considered dangerous.

The symptoms are usually those of an irritant, i.e., nausea, vomiting, pain in stomach and abdomen, dyspnœa, diarrhœa, and the like, with, when severe, more or less collapse. But besides this it has a characteristic action upon the blood, breaking down the red blood-cells, and changing the hæmoglobin into brownish methæmoglobin.

This results in changes, inflammation, and swelling of the liver and spleen, and in very marked trouble with the kidneys. These become highly congested, producing small amounts of brownish, thick urine, full of albumen, and of brownish-red casts containing broken-down blood-cells. Following this frequently come nervous symptoms, headache,

[illegible] twenty-four [illegible] twenty-five [illegible] grains, while [illegible] twenty-five

[illegible] pungent smell [illegible] and ether. [illegible] rapid caus- [illegible] internally it [illegible] reported where [illegible] death, with [illegible] seven and a half

[illegible] are more or [illegible] *Biol.*, 1891. [illegible] the salt most [illegible] and fif- [illegible] may be substi-

[illegible] and is largely [illegible] excessive excitement. [illegible] children, sexual [illegible] strychnine poi- [illegible] given in large doses. [illegible]

[illegible] taken for too great a [illegible] the nervous system. [illegible] stupid, difficult to [illegible] dizzy on slight exer- [illegible] are much depressed. [illegible] They also generally [illegible] of the skin, eyelids, [illegible] a fetid breath. Occa- [illegible] These cases usually [illegible] given plenty of water so

as to wash the salt from the system, but occasionally they result in death from exhaustion, heart-failure, and collapse.

The time of death, and also the fatal dose, varies greatly. In one case (Dr. Hamer, *Columbus Med. Jour.*, 1884, vol. iii., p. 259) a woman was given eighty-five grains of the salt every four hours. After four days another doctor found her almost comatose, muttering to herself, with a temperature of 95½°, weak rapid pulse, very anæmic, passing little, albuminous urine, and with pain in head and over ovaries. The medicine, she said, burned her mouth and throat whenever she took it. In spite of treatment she died in eight and a half days from the first dose.

In another case (*Brit. Med. Jour.*, 1882, part i., p. 616), a doctor called to treat a child recovering from convulsions prescribed five grains of potassium bromide every four hours. After the first dose the child seemed much better, but, a few minutes after, drank down most of the medicine, some eighty grains in all. In ten minutes the child became pale, with blue lips, and lay down to rest; and within five minutes more it died quietly.

In general the symptoms of "bromism" come on gradually, with ordinary-sized doses, and can be recognized in time to prevent serious injury.

Iodine—I.

This occurs in soft, bluish-black, crystalline scales, having a metallic luster and an irritating smell and taste. It volatilizes slightly at ordinary temperatures, and at about 220° F. it melts and changes into a violet vapor. It is almost insoluble in water, but dissolves freely in a solution of potassic iodide, and also in alcohol, and ether. Its solutions turn starch blue.

Externally it acts as a powerful irritant, and if very strong, as a caustic. It is largely used in medicine for producing local counter-irritation, and for this purpose is painted on the skin, in the form of a tincture. If the latter is strong, and is applied repeatedly, it will produce blisters and very decided inflammation.

When swallowed, it acts as a powerful irritant, and when in moderate-sized doses, ten and twenty grains, has been known to produce death, with the usual symptoms of a corrosive poison.

It also has certain specific effects when absorbed into the system, either from injection into a cyst or cavity, or by being painted on an ulcerated surface. Under these circumstances it produces more or less gastric irritation, shown by vomiting, purging, and the like; also some nervous symptoms, neuralgia, disturbed intellect, dizziness, and so on; and finally, by its elimination, produces considerable inflammation of the kidneys, and often an eruption on the skin.

An interesting case of acute iodine poisoning is given by Dr. Culpeper (*Therap. Gaz.*, 1888, vol. iv., p. 225). A colored woman painted both legs of her eleven-year-old boy with a solution of iodine strong enough to take off all the skin from above his knees to below his ankles. This was done at night, and all night and next day the little fellow complained of much local pain. At night he had a headache, with pain in stomach, bowels, and bladder, and in the back over the kidneys, and passed no urine.

The second day he was worse, with diarrhœa and vomiting, and the

third day these symptoms increased. On the fourth day he was suffering from vomiting, purging, and hiccoughing, and iodine was found in both fæces and vomited matter. He was very dizzy and had fainting-fits, while no urine was passed at all, and after five and a half days he died quietly, after passing almost pure blood.

His temperature did not rise above 98.8°, although there was much raw surface; there was total suppression of urine from the beginning; his intellect was clear, although he was very giddy on taking the least exertion, and he had constant symptoms of gastric irritation.

Potassium Iodide, KI.—This salt is given in very large doses, especially in the latter stages of syphilis, and is usually borne quite well. It must, however, be used carefully, or it will give some of the symptoms of iodine poisoning, beginning, usually, with a rash, and continuing with cerebral symptoms, and sometimes with lowering of temperature. These effects, as a rule, are not dangerous, and are easily cured after stoppage of the drug.

IV. PHOSPHORUS.

This substance was discovered by Brandt, in 1669, in the residues from urine, while searching for the philosopher's stone. It was named from its power of shining in the dark, and for a hundred and fifty years was regarded almost solely as a curiosity. In the early part of this century it was introduced for the manufacture of matches, and afterwards as a vermin killer, and since then has been manufactured in large quantities.

Phosphorus never occurs in nature excepting when combined with oxygen or some other element. Its compounds, however, especially the (ortho)phosphates of calcium, magnesium, sodium, and potassium, are found, widely distributed, in the form of rocks and minerals, in all soils, in almost all natural terrestrial waters, and in the tissues and fluids of plants and animals. In the latter it chiefly occurs in the bones and the brain tissue.

It is prepared from the ashes of bones, which are principally composed of calcium phosphate, by separating the calcium with sulphuric acid, and distilling the resulting acid with charcoal.

Properties.—It is a light yellow, translucent, horn-like solid, which can be easily cut, and which appears in commerce usually as small sticks covered with a whitish coat. It has no taste, but a peculiar garlic smell. It ignites in the air at 100° F., but when in an inert atmosphere like carbon dioxide, or under water, it melts at 109° F.

It is practically insoluble in water, but dissolves freely in carbon disulphide, and to a less extent in oils, concentrated acetic acid, and ether. By suitable treatment it can be changed into two if not three other varieties of phosphorus. One only of these is important, the red phosphorus, which is a red powder, insoluble in the above media, far less combustible than the common form, and non-poisonous. In commerce, however, it almost always contains a small percentage of the yellow or ordinary phosphorus.

Physiological Properties.—In small quantities, this element acts as a stimulant to the nutrition of the tissues, and especially of the nerve-centers. It is, therefore, much used in exhaustion, or even disease, of

the spinal or brain-centers, in neuralgia, anaphrodisia, incipient myelitis, and the like. It also stimulates the formation of bone tissue, and is often employed, with iron, in cases of osteomalacia, rickets, and similar diseases. In experiments on animals the spongy tissue becomes denser, and the hard tissues thicken, in some cases till the canal is almost filled up.

Poisonous Properties.—These have been recognized ever since phosphorus was manufactured for commercial purposes. In this country and England cases of poisoning by it have been mostly confined to accidents or murders; but on the Continent, and especially in France, it is much used for suicide, and, some years, heads the whole list of poisons. It has the advantage of being cheap and easily obtained, but it produces great suffering and, usually, a slow, lingering death.

Symptoms—Rapid Cases.—In some cases, perhaps ten or fifteen percent., a fatal dose of phosphorus will act promptly and produce death within twenty-four hours or so. Under these circumstances the first symptoms are usually retching and vomiting, with sharp pains in the epigastrium, and an odor of phosphorus both in the breath and vomited material. These symptoms often improve instead of growing worse, but the patient sinks into a state of collapse, and dies in coma, or in convulsions.

Death may occur, under these circumstances, in but a few hours after taking the poison. Von Maschka (*Wien. Med. Wochensch.*, 1884, pp. 608, 648) reports in detail two cases of his own, of a girl twenty-seven years old and a man sixty-one years old, each of whom died in eight hours; and quotes cases of death in eight, seven, and four hours respectively. The last case, which is quoted from Kessler, was of a child seven weeks old, who had sucked the heads from six or seven matches.

Symptoms—Ordinary Cases.—In the great majority of cases the first symptoms do not appear for some hours or even days after the poison is taken, and then are not very severe. They consist of a feeling of weakness and general ill-health, with some nausea, and, perhaps, vomiting, and some epigastric pain. The vomited matter and the breath usually smell of phosphorus, and occasionally are luminous in the dark.

These symptoms, especially under treatment, get no worse, and indeed often improve, for one or two days or even longer. There may be slight fever, thirst, loss of appetite, and the like, but nothing to cause much alarm.

Then come symptoms of jaundice, usually beginning with yellow coloring of the conjunctivæ and the presence of bile in the urine. The skin becomes yellow, the stools are liver-colored, and finally almost white —"chalk and water," as they are frequently described—the liver becomes considerably enlarged, and is painful on pressure.

The kidneys also are affected, as is shown by the urine being scanty, full of albumen, often containing casts and blood, and, sometimes, glucose. Bile acids and bile pigments are present in it, and not infrequently leucine and tyrosine; while under the microscope can be seen small fat-globules, partly free in the liquid, partly in epithelial cells.

The patient by this time is dangerously ill; nervous symptoms, such as delirium, frequently of an erotic character, or a heavy comatose sleep, set in. The temperature may fall very decidedly, but not infrequently rises, sometimes very high; and the patients finally die of collapse, sometimes in coma, sometimes in convulsions.

Occasionally, with these signs of liver disease, come some peculiar symptoms of the blood. The blood becomes dark, not easily coagulated, if at all, with fewer red and more white blood-cells, and gives rise to bleedings from different parts of the body. Women frequently flow freely, as at menstrual periods (they invariably abort or have a miscarriage when in pregnancy), and there may occur obstinate bleedings from the gums, nose, kidneys, or bowels. In these cases the disease may last for a long time, and the patients finally die of anæmia.

Post-mortem Changes.—In the ordinary cases there will be found an extreme fatty degeneration of the liver and kidneys, and also generally of the heart, lungs, and, in fact, almost all the tissues of the body.

The liver, in the early stages, is much enlarged, but afterward diminishes in size, and may be much atrophied. It always, however, has more or less of a yellowish look when cut, and contains little or no blood. Pieces of it will sometimes burn freely when touched with a lighted match. Under the microscope the cells appear much broken down and full of fatty globules.

The kidneys present similar appearances. The cortex peels off easily, and on section the tissue has a yellow color and a greasy feeling.

The lungs and heart also show signs, generally, of fatty degeneration; the blood is dark colored, and forms numerous ecchymoses in the endocardium, the mediastinum, and, in fact, all over the body.

It used to be stated that phosphorus produced inflammation, and often ulceration, of the stomach and intestines. It really produces, rather, a gastro-adenitis—i.e., the mucous membrane becomes much thickened, white, and opaque, from a great enlargement of the glands and a fatty degeneration of the epithelium. This also is the case with the intestines.

Phosphorus Poisoning vs. Acute Yellow Atrophy of the Liver.—When jaundice has once set in it is almost impossible, by clinical means, to distinguish between these two forms, if the liver, in the phosphorus cases, has had time to contract. In the earlier stages it enlarges a good deal, and does not, as a rule, get small until the jaundice has lasted two or three days.

It is claimed that in acute yellow atrophy there is far more leucine and tyrosine in the urine than in phosphorus poisoning; and also that the intestines contain gray-white, knotty fæcal matter, while in the phosphorus cases the excreta are usually fluid.

These differences, however, are slight, and it is better to trust for distinction upon tests for phosphorus, either in the early vomited matter, or in the intestines and tissues after death.

Time of Death.—These cases usually die in from three to seven days, though they sometimes linger ten days or a fortnight. Out of 129 cases of all kinds looked up by Dr. Blyth, 17 died within twenty-four hours, 30 within two days, 103 within seven days, 22 more before ten days, and 4 lived for more than ten days, 1 dying at the end of eight months.

Treatment and Antidotes.—When once the phosphorus has been absorbed in the circulation in sufficient amounts to produce the liver lesions, treatment is of but little value. The poison must be ejected as far as possible, before it is absorbed, by vomiting and purging, and then what remains must be, if possible, rendered inert. It is not absorbed

very quickly, for free phosphorus has been found in the fæces for two or three days after it was taken.

There are two antidotes to phosphorus, of more or less value, cupric sulphate and oil of turpentine. The copper salt forms a black phosphide of copper, which is harmless and can be removed, it is said, by the kidneys. So it is good practice, when a patient is brought in, to give him an emetic of three grains of cupric sulphate in some water, and to repeat it at frequent intervals.

The use of oil of turpentine was introduced by Andant, who in 1868, it is said, met a case of a man who, to commit suicide, took a lot of phosphorus paste, and then, to hasten his end, took a good drink of turpentine. To the great astonishment of both physician and patient the symptoms were slight, and recovery was rapid.

At any rate, some kinds of oil of turpentine, probably turpentines that have been exposed to the air for a long time, have undoubtedly the property of making an inert, gelatinous mass with the poison, and also, very possibly, help to oxidize it and thus make it harmless. One experimenter, Personne, poisoned fifteen dogs with phosphorus, and gave turpentine to ten, all of whom survived, while the other five died with the characteristic symptoms.

It should be given in doses of from thirty to forty minims (2 to $2\frac{1}{2}$ gr.) every half-hour or so, for two or three days.

Dangerous and Fatal Doses.—The medicinal doses of phosphorus vary from one thirtieth to one twelfth or even one quarter of a grain. In an interesting paper Mr. Thompson (*Practitioner*, 1872, part ii., p. 13), giving his experiences in neuralgia, advises starting with one eighteenth of a grain every three hours, and increasing to one twelfth of a grain and higher. He tells of one case where a person took one quarter of a grain four times a day, for three days, without injury. On the other hand, on page 103 of the same volume, Dr. Anstie tells how a man taking one thirtieth of a grain three times a day for six or seven days (under three quarters of a grain in all) developed distinct symptoms of poisoning. The subject, in this case, was highly neurotic.

Death has been more than once reported from quantities of phosphorus varying from one to two grains. Sir R. Christison gives two fatal cases, one from one and a half grains and the other from about two grains, and Galtier, a case where a woman died from taking about one grain in the course of four days. A case was reported by Löbel of Jena where a lunatic was killed by a dose of one eighth of a grain.

It is fair, accordingly, to state that from one to two grains would constitute, as a rule, a dangerous if not fatal dose.

It is not necessary for the poison to be taken internally. A curious case is reported by Dr. Hill (*Lancet*, 1890, part i., p. 398), where a servant-girl, wishing to give an interesting "dark séance" to her fellow-servants, rubbed some phosphorus paste on her face and hands. The resulting illumination was satisfactory enough, but the poor girl died, with characteristic symptoms, on the eighth day.

Poisoning by Phosphorus Vapor—Necrosis of the Jaw.—Soon after phosphorus was manufactured on a large scale, it was noticed that workmen exposed to its fumes were subject to a peculiar disease of the jawbone. In 1845 twenty-two cases were reported in Austria, and two years later Von Bilva and Geist discussed fully the etiology of sixty-

eight cases in Germany. Of late years, thanks somewhat to improved ventilation, enforced cleanliness, washing the mouths with alum and alkaline solutions, and rejection of workmen with unsound teeth, and, more than all these, to the use of red phosphorus, the disease has almost disappeared.

The first symptoms were usually those of a severe toothache, generally in the lower jaw. This would become worse, and the aching teeth would be pulled out, thereby relieving the pain. But the wound in the gum would not heal; offensive matter would ooze out, and the sockets of the teeth would become bare and exposed.

Occasionally this bare piece of bone would slough off, with two or three neighboring teeth, and the wound would heal up all right. But generally the disease would spread slowly or fast; more of the jaw would become involved, the teeth falling out and the bone being laid bare. The gums would become swollen and infiltrated, offensive pus would exude, and often, if not treated, in the course of some months or years, the patient would die of debility, septic pneumonia, or the like; or else get well, though horribly deformed by the loss of large masses of the jaw.

The disease, it would appear, is a purulent inflammation of the marrow of the bone (osteomyelitis), and spreads from the interior toward the periosteum. The poisonous fumes are usually supposed to enter the system through a decayed tooth, but this does not seem invariably to be the case.

The treatment usually adopted is an immediate removal from the exposure, followed by a pretty free use of the knife. The dead bone is removed wherever possible, and the wound opened up, and thoroughly cleansed by irrigating constantly with antiseptic washes. If carefully done it is possible to remove the decayed bone, leaving the periosteum intact, in which case new bone will frequently form and preserve both the strength and the shape of the original jaw. A case of this sort, where a whole lower jaw was removed from a girl by Dr. Wood, at Bellevue, in 1857, is commented on most favorably, as a specimen of American surgery, in the *Lancet* (1877, part i., p. 813). The patient recovered from the operation, and died of some brain disease three years after the operation, and the jaw was found to be completely re-formed. It was preserved as a curiosity, and, twenty years afterward, was exhibited at a Medical Congress at Berlin, much to the interest of the European physicians.

Tests for Phosphorus.—The vomited material, as well as the fæces, urine, and even the breath, will generally, in the early stages of poisoning, have a peculiar garlic smell, and shine in the dark. Besides this there are two methods, one discovered by Mitscherlich and the other by Dusart, for obtaining good evidence of the presence of minute traces of phosphorus or phosphorous acid.

Mitscherlich's Test.—If a mixture containing phosphorus is acidulated with sulphuric acid and carefully distilled on a sand-bath, and the vapors condensed in a glass condensing-tube in a dark room, any phosphorus present will be volatilized, and, in condensing, light up the tube. If present in any quantity, its amount can be determined by oxidizing it with nitric acid, and then precipitating it with ammonic molybdate, or ammonio-magnesic sulphate, and weighing. But, in this case, care must be taken that nothing from the flask is allowed to spatter over into the condenser.

This luminosity can be observed for quite a time, half an hour or more, with one fortieth or one fiftieth of a grain of phosphorus, mixed with several ounces of liquid. It is interfered with by the vapors of alcohol and ether, which would be quickly volatilized, and of oil of turpentine; also by calomel, corrosive sublimate, and large quantities of iodine. It is not affected, however, by the presence of organic matter.

Phosphoreted Hydrogen Test.—This gas is formed by the action of nascent hydrogen on free phosphorus or on its lower oxides, and burns with a characteristic green flame. Hence, if a suspected solution is placed in an evolution-flask containing zinc and dilute sulphuric acid, from which the hydrogen, passing through a drying-tube containing caustic potash or lime, is led to an ignition-tube and is there burned, the color of the flame, if phosphorus be present, will change from a faint blue to a brilliant green. This flame can be further tested by the spectroscope. The end of the tube should be kept cool in this experiment.

This test will show the presence of phosphorus in as small amounts as the Mitscherlich test, and is not interfered with by anything that is likely to be present.

V. ANTIMONY.

History.—This element was known to the ancients both in its metallic state and in its salts. The metal, known as stibium, was used to some extent by both Greeks and Romans, while the black sulphide, now called stibnite, which is the commonest form in which antimony occurs in nature, has been used from time immemorial up to the present day, in the East, on account of the fine black powder obtained from it. This is mentioned not only in comparatively recent tales, like the *Arabian Nights,* where the women always paint and touch up their eyebrows and eyelashes with "kohl," but is even alluded to in the Bible, when Jezebel, before putting her head out of the castle window to greet the victorious rebel, Jehu, "painted her face," or, as the other translation gives it, "put her eyes into painting."

The name antimony was given to it in the middle ages by Basil Valentine, a German monk, who, early in the fifteenth century, described its medicinal powers in a book *Currus Triumphalis Antimonii.* The story goes that while studying the properties of some of the metals he threw the refuse from some of his experiments into a pig-pen, and was interested to see that, although the pigs were violently purged, they grew fat and strong under the treatment. He accordingly put some in the food at the convent, but, whether from his carelessness or the poor constitution of the good brothers, he killed nearly all of them. Hence the nickname antimony—"bad for the monks."

Paracelsus was one of the first to parade its virtues, and he brought it into wide notice, but, at the same time, into much disrepute among the regular practitioners, so that in 1556 the Faculty of Physic at Paris condemned it as a poison, and the Parliament prohibited its use under heavy penalties. As late as 1609 they expelled a doctor from their faculty for using the drug, and Guy Patin, a famous professor in Paris, published a *Martyrology of Antimony* giving great lists of the victims from it. Its use, however, gradually spread, tartar emetic was discovered

in 1631, and a few years later it was restored to the pharmacopœia, and its use made general.

Later it was used as a panacea; it was claimed to be an emetic, purgative, diuretic, stimulant, sedative, anti-scorbutic, and a cure for acute mania. Cups were made of antimony glass, an impure oxide, which gave purging properties to liquids drunk from it. It is still used in medicine, in the form of tartar emetic, to a moderate extent, but the excessive claims for it have disappeared.

Its salts are active poisons, although not generally used as such, and cases of poisoning by it are not very common, excepting when taken accidentally. Taylor, in 1857, collected thirty-seven cases, of which sixteen were fatal, and in the course of that year investigated three or four cases of murder. Since then it has been of less importance, although every now and then it has been the basis of some famous trials—the Pritchard case and the Bravo or Balham case in England, and the great Wharton case in this country, some details of which last will be given later.

Preparation and Properties.—The metal is usually prepared by roasting and reducing the sulphide, stibnite. It is a grayish white, brittle solid, with metallic luster, and without taste or smell. It crystallizes readily, and is volatile.

It does not oxidize in the air at ordinary temperatures, but when heated it burns to the oxide, Sb_2O_3. It dissolves in hot concentrated sulphuric, hydrochloric, and nitric acids, but not in alkalies or solutions of hypochlorites. It is probably not poisonous, unless, possibly, when inhaled as gas, when it may easily become oxidized, and then produce characteristic symptoms.

Its two important compounds are tartar emetic, and antimonious chloride or butter of antimony.

Tartar Emetic, $KSbOC_4H_4O_6$.

This compound, formed by boiling antimonious oxide with cream of tartar, is sold as a white, crystalline powder, with a nauseous, styptic, metallic taste. It is readily soluble in hot, and less so in cold, water; strong alcohol fails to dissolve it, but proof spirits and wine dissolve it according to the amount of water which they contain. It crystallizes from its solutions in the form of colorless, transparent crystals of the rhombic form.

Its aqueous solutions decompose readily, on standing, by the action of molds and algæ, which form a stringy deposit in the liquid. It is also decomposed by acids, alkalies, plumbic acetate and subacetate, and by astringent solutions containing tannic acid, which forms a more or less insoluble compound with the metal.

Physiological Effects.—These have been studied on animals as well as on man.

Externally.—When antimonial solutions are rubbed on the skin some local irritation is produced, but the effects are slight. When antimonial ointments have been used in some quantities, the local irritation may get so severe as to form true pustular eruptions which look a good deal like smallpox, accompanied by the specific effects of vomiting and purging, and a lowering of the arterial tension.

Similar results have been produced on animals by inhaling antimoniuretted hydrogen.

Internally.—Minute quantities produce, usually, but a slight nausea and discomfort. As the dose increases these symptoms get worse, until with one third or one half of a grain, as a rule, the patients begin to vomit.

With still larger doses the vomiting becomes more and more severe, with retching, much discomfort, increased perspiration, diminished pulse, muscular weakness, and even faintness.

Poisonous Effects.—When the danger limit is reached the vomiting will usually be violent and incessant, bringing up mucus, often stained with bile, and finally even with blood. This seems to be caused, to some extent, by the local, irritant action of the drug, but, for the most part, by the action of the absorbed antimony upon the vomiting center in the medulla. It has been observed in animals when a rubber bag was substituted for the stomach, and is also generally present when antimony is given externally.

The intestines are also affected, and there is violent and severe purging, the stools becoming more and more watery, and often having the "rice-water" appearance noticed in cholera. Later they may be bloody. There is generally pain and purging in the œsophagus and stomach, and a great deal of thirst. The resemblance to cholera is often strengthened by cramps in the extremities.

The urine is often increased at the outset, but, a little later, is generally scanty, sometimes containing blood, and may be completely suppressed.

The nervous system is often affected, with more or less loss of sensation, and occasionally with convulsions. The patients almost always are greatly depressed, and feel wretchedly weak and miserable.

The circulation is affected very early, the arterial tension being lowered by the action of the drug not only on the heart-centers themselves, but also on the peripheral vasomotor system.

Finally, when the severe symptoms have lasted for some time, there are distinct signs of collapse. The face becomes pale and haggard, the eyes sunk, the skin cold and clammy, the extremities cold, the pulse weak, the respiration slow. Death may occur from exhaustion, in a stupor, or in convulsions or even delirium.

Other Symptoms.—Occasionally, the vomiting and purging is slight or even absent, and the victims suffer from intense prostration, almost from the start, and die from failure of respiration and circulation, owing to the action of the drug on the centers in the medulla.

Chronic Cases.—In other cases the drug is administered in small doses repeated at successive intervals. The same amount of poison is more apt to kill in this way than when given in one large dose, because in the latter case it is often rejected at once by the violent vomiting. These chronic cases are characterized by nausea and persistent, though not very violent, vomiting, with purging or, occasionally, constipation, and with very marked depression. The food cannot be digested, the circulation gradually fails, and the patients get weaker and weaker, and finally die of exhaustion.

The Pritchard Case.—Instances of both acute and chronic antimony poisoning occurred in the above case (*Edin. Med. Jour.*, 1865, vol. ii., p. 163, and *Archives. Gen.*, 1865, part ii., p. 267), where a doctor, in good practice in Glasgow, was convicted of murdering both wife and mother-in-law.

His wife was taken down, in the autumn, with nausea, vomiting, and general ill-health, and after a week or two went to Edinburgh to visit her parents, and improved rapidly. On her return she again began to suffer from retching, vomiting, cramps, pain in the stomach and intestines, and great prostration, and finally died some ten weeks after she came back.

While she was ill, her mother, Mrs. Taylor, came on to nurse her, and was attacked with similar symptoms a day or two after her arrival. She then recovered; but one evening, a fortnight later, after taking some supper, she became violently ill, vomited, and then fainted, fell into a comatose state soon afterward, and died of collapse in six or eight hours.

Chemical examination of the remains showed the presence of antimony in the organs, blood, and urine of both victims, and tartar emetic was also found in food and medicines used by them both. It was believed that Mrs. Pritchard's case was a characteristic one of chronic poisoning, but that Mrs. Taylor died from acute antimony poisoning complicated by the presence of a little mercury, and possibly of some opium.

Post-mortem Appearances.—These usually indicate more or less inflammation of the stomach, and also of the intestines. They are not, as a rule, very marked, and in a few cases have been entirely absent, as, for instance, in the body of Mrs. Taylor, just mentioned. The blood is unusually fluid, and the viscera are frequently much engorged; the lungs, especially, are apt to show signs of emphysema, effusion into the pleura, and the like.

Indeed, it may be said that there are no particular lesions distinctly characteristic of antimony poisoning, and death from the latter has not infrequently taken place with but slight changes in the body.

Prognosis.—Antimony poisoning differs very distinctly from arsenic poisoning, which, in some respects, it resembles by responding more or less well to treatment. In the first place, the poison is largely eliminated from the system by the incessant vomiting and purging, and what remains unabsorbed can be neutralized by giving solutions of tannin, or of green tea or other vegetable astringents, and also of albumen, all of which form comparatively insoluble compounds with the antimony. The depression and prostration, which form such a marked feature of the illness, must be counteracted by stimulants and warmth.

Thus cases are reported of recovery from doses of one hundred and seventy grains (*Med. Rec.*, 1883, vol. xxiv., p. 401), and of half an ounce (*Am. Jour. Med. Sci.*, 1853, vol. xxv., p. 131) and even more, of tartar emetic, after it had been largely absorbed and had produced characteristic symptoms.

Dangerous and Fatal Doses.—It is very hard to determine with this poison at what size of dose to fix the danger limit. Cases are on record where very violent symptoms have been produced with minute quantities. Thus Dr. Richardson (*Lancet*, 1856, part i., p. 400) prescribed for a patient, who had warned him that he was easily affected by antimony, fifteen minims of antimony wine (two grains of tartar emetic to the ounce), causing thereby incessant nausea for many hours, with abdominal pain and griping, faintness, general exhaustion, and such prostration that the victim could not leave his room for three or four days. Other cases are reported where really serious results came from half a grain or so of the poison.

Death has been caused in a child recovering from measles by three fourths of a grain in one hour, and in a medical student, with all the usual symptoms of acute poisoning, by two grains. Other fatal cases have been reported, in children from doses of ten and fifteen grains, and in adults from twenty grains and over.

According to Taylor, doses of from ten to twenty grains are distinctly dangerous for adults, if taken at one time, and less than that if taken in divided doses.

On the other hand, undoubted tolerance exists in many persons, both in health and disease, for very much larger doses. Thus in the old-fashioned treatment of pneumonia, abandoned now for some years, and also in pleurisy and fevers, it was thought good practice to give twenty, forty, sixty grains, and even more, in twenty-four hours, in doses of from two to five grains each. In most cases these did not cause emesis, purging, or other severe symptoms, and in some cases, at least, they seemed to be of benefit to the patient.

It was customary, in these cases, to try to establish a tolerance in the first day or two, after which the heroic treatment could continue without much danger. If, however, after the second day emesis and purging continued, it was very dangerous to push the drug any further. As it was, a good many patients probably died from the treatment, even if cured of the disease.

Time of Death.—As before mentioned, Taylor reports a case of a child dying from tartar emetic in three quarters of an hour.

In healthy adults death has occurred from this poison in seven hours, and two or three deaths have been reported in ten hours. As a rule, however, the patients live for twenty-four hours at least, and generally die in the course of some days after the fatal dose.

Elimination of the Poison.—The poison absorbed into the system is eliminated with considerable rapidity by the kidneys, and also in the milk, and through the mucous membranes of the stomach. To prove the latter, Dr. Brinton (*Lancet*, 1853, part ii., p. 599) injected ten grains of tartar emetic into the femoral artery of a dog, who at once fell in collapse, and in fifteen minutes antimony was found in the contents of the stomach.

The poison is also eliminated by the liver, and in chronic cases it is common to find inflammation of both liver and kidneys.

But, more than other poisons, tartar emetic is largely expelled from the body by vomiting and purging, so that it is impossible to tell how much of a given dose ever enters the circulation at all. It is this property which causes such uncertainty about the size of a fatal dose.

For all these reasons, in a chemical examination it is very rare to find any large amount of antimony in the body, and to insist, as lawyers are fond of doing, that unless a full poisonous dose is isolated from the tissues the victim did not die of antimony poisoning, is absurd. Indeed, while criminals have been convicted of antimony poisoning, and plenty of bodies undoubtedly poisoned by antimony have been analyzed, it is doubtful if such quantities of absorbed antimony have ever been separated from a dead body.

To illustrate this, it may be mentioned that in the Pritchard case, above mentioned, antimony was found in all the tissues and organs of the bodies of both women, but in small quantities, the liver, intestines,

kidneys, and stomach of Mrs. Taylor containing about one and a half grains, and the same organs of Mrs. Pritchard, about four and a half grains. In the Ann Palmer case, in 1865, the internal organs contained about four grains, and in the Hardman case, from one half to three fourths of a grain.

Tests for Antimony.—(*a*) *Sulphureted Hydrogen.*—If this gas is passed through a warm solution of tartar emetic or other antimony salt, acidified with hydrochloric acid, there will be formed an orange-red precipitate of antimonious sulphide, Sb_2S_3. The precipitate readily dissolves in concentrated hydrochloric acid and in caustic alkalies, but not in ammonic hydrate. This hydrochloric acid solution, when cold, if added to several times its bulk of water will form a white precipitate, which dissolves readily in tartaric acid.

This test is very delicate, being perceptible with 1–10,000 of a grain of antimonious oxide in five grains of solution; but when made in complex solutions containing organic matter and other compounds, the color of the precipitate is often obscured by the color of the solution, and the precipitate itself may be masked by the precipitation of sulphur.

(*b*) *Reinsch's Test.*—When a bright strip of metallic copper is boiled with a solution of antimony acidified with hydrochloric acid, the copper will become coated with a violet or gray coating of metallic antimony. This may easily be mistaken for the similar deposits made by arsenic, bismuth, mercury, and other metals.

The deposits of antimony, arsenic, and mercury will produce sublimates, when the washed and dried slips of copper are heated in a small reduction-tube. The antimony sublimate will be near the slip, and amorphous or granular, with very few if any crystals; while the arsenic will sublime half an inch or so from the copper and consist almost wholly of octahedral crystals. The mercury sublimate is composed of small globules.

But, better than this, if the coated copper is boiled with a dilute solution of caustic potash, the antimony will dissolve, especially if the copper is lifted out and exposed to the air every now and then. This solution, when acidified with hydrochloric acid and concentrated, will give an orange-red precipitate with sulphureted hydrogen.

(*c*) *Zinc Test.*—If a drop of an antimonial solution, acidified with hydrochloric acid, is placed in a platinum dish, and a small piece of zinc is placed in it, there will form on the platinum a black or brownish stain of metallic antimony. This can be identified by moistening it with nitric acid, evaporating it to dryness, and touching the spot with ammonium sulphide, which will form orange-red antimonious sulphide.

(*d*) *Marsh's Test.*—This test, when made exactly as described in the next section under the tests for arsenic, will give similar reactions for antimony. In case it is thought best to test the gas by making stains on porcelain, or by depositing the metal in the tube, by the Berzelius Marsh test, the antimony can be distinguished from arsenic by not dissolving in a hot, strong solution of bleaching powder. They both dissolve in yellow ammonic sulphide solution, but antimony leaves, on evaporation, orange-red stains of antimonious sulphide, insoluble in ammonia, and soluble in concentrated hydrochloric acid, while the deposit of yellow arsenious sulphide, formed in the same way, dissolves in ammonia, but not in hydrochloric acid.

A better and more satisfactory method of distinguishing the two metals is by passing the gas into a solution of argentic nitrate. The antimony will be deposited as black argentic antimonide, Ag_3Sb, while any arsenic present will dissolve in the liquid. To prove the presence of antimony in the deposit, the latter is filtered off (the filtrate being reserved so as to examine it later for arsenic) and boiled with dilute hydrochloric acid, which will dissolve the antimony and not act on the silver. The latter is then filtered off, and the solution tested with sulphureted hydrogen.

This test is extremely delicate, and will give a good deposit (Wormley) with 1–20,000 grain of antimonious oxide, or 1–8000 grain of tartar emetic.

Separation from Organic Material.—When examining material like food, medicines, vomited matter, the contents of the stomach and intestines, and the like, it is possible to extract antimony by acidulating with a little hydrochloric acid, and then heating with tartaric acid, straining, and filtering. The solution is then treated with sulphureted hydrogen and allowed to stand for some hours, and the precipitate filtered off.

This precipitate, which will contain all the antimony as sulphide, along with sulphur and the sulphides of other metals, should be boiled in strong hydrochloric acid, until the sulphur fumes have disappeared, and then filtered, if necessary. This solution can be tested by the zinc and Reinsch's tests, and also by the addition of a large quantity of water, in which case the resulting white precipitate should be soluble in tartaric acid, and react with sulphureted hydrogen. Or it may be placed in a Marsh's apparatus and passed into argentic nitrate.

In examining the tissues for absorbed antimony the organic matter should be destroyed as thoroughly as possible by boiling with hydrochloric acid and potassic chlorate, and the antimony separated from the solution, as before, by sulphureted hydrogen.

When the exact quantity of antimony is to be determined, the precipitate thus obtained should be purified by evaporation in an evaporating-dish with some strong nitric acid, and then, after moistening the residue with a strong solution of potash, by reëvaporation and fusion. The antimony is then dissolved out with boiling tartaric acid, and reprecipitated by sulphureted hydrogen, after adding a little hydrochloric acid. This precipitate, carefully washed, can be collected on a weighed filter, washed, dried, and weighed.

The Wharton Case.—The whole question of the tests for antimony was worked over most carefully in connection with this famous case. In 1872 Mrs. Wharton, a member of a well-known and prominent Maryland family, was tried for the murder of General Ketchum. The latter had been taken violently ill while visiting at her house, and died, under rather suspicious circumstances, a few days later; while, at the same time, another friend of the family had suddenly fallen ill and nearly died, after taking some refreshments in the same house. In both cases there were various money transactions which might have acted as an inducement for a crime, and also, in both cases, suspicious-looking sediments were found in liquids given the invalids by Mrs. Wharton.

The symptoms of General Ketchum, and the post-mortem condition of the body, were consistent with, though not especially characteristic of, antimony poisoning, so the case turned entirely upon the chemical evidence.

The latter indicated the presence of tartar emetic in considerable quantities in both the liquids mentioned and in the stomach of General Ketchum. But unfortunately, in every case, the original solutions and the resulting precipitates were thrown away, so that, when the tests were disputed, it was impossible to confirm them. The principal chemical witness for the prosecution testified that both the sediment in a glass of milk punch, and the contents of the stomach, gave a brownish-red precipitate with sulphureted hydrogen, after acidifying with hydrochloric acid; that this dissolved in boiling hydrochloric acid; that this solution, when diluted with large amounts of water, gave a white precipitate, which dissolved in tartaric acid, and gave an orange-red precipitate when the tartaric acid solution was again treated with sulphureted hydrogen.

The above tests are a pretty certain indication of the presence of antimony, but they were not confirmed by any others, except by a very unsatisfactory Marsh's test made by another chemist. Nor were any of the precipitates saved or shown in court, although the amount of tartar emetic in the stomach was estimated roughly at twenty grains. Besides this, no attempt was made to remove any, far less all, of the organic matter, before making the tests.

This carelessness ruined the case, for several experts were brought in to testify that the metal itself, under those circumstances, should have been produced. They even went to the extreme of making up a solution of gelsemium extract, chloral, beef tea, white of egg, and milk, which they claimed was a fair reproduction of the contents of General Ketchum's stomach after death, and, by using nearly though not quite the same steps, produced results which to the jury seemed to agree more or less closely with those produced by antimony. In short, they fought so hard that the jury disbelieved the chemical evidence on the other side, and accordingly acquitted the prisoner.

Whether the testimony of some of the experts did not overstep the limits of scientific and impartial evidence is an open question; but there is absolutely no doubt that, in any case of this sort, a chemist is unpardonably careless unless he saves with the utmost care everything submitted to him, and preserves, and brings into court, if at all possible, every particle of poison that he can isolate. (See the Wharton trial, published by *Balt. Gazette*, 1872; also Reese, *Am. Jour. Med. Sciences*, April, 1872; Williams, *Med. and Surg. Reporter*, 1872; Aiken, *Richmond and Louisville Med. Jour.*, 1873, vol. xv., p. 7; and others.)

Butter of Antimony—Antimony Chloride—$SbCl_3$.

This compound, which at ordinary temperatures is a yellow semi-solid mass, not unlike butter, is used to some extent in pharmacy, dissolved in hydrochloric acid, and is occasionally met with in cases of poisoning.

Its first symptoms are those of an active irritant or sometimes corrosive poison, followed by extreme exhaustion and signs of collapse in the course of a very few hours. If this stage can be passed there is a fair chance of recovery, the few deaths recorded taking place within twenty-four hours. (See Taylor, *Treatise on Poisons.*)

For treatment it is well to give magnesia and other mild alkalies in milk, albumen solutions, and the like. Also to give infusions of tannin, and to treat the symptoms of collapse with stimulants.

A simple test for this substance in solution is the addition of a large amount of water, when a white precipitate of oxychloride will be formed.

Antimoniureted Hydrogen.

According to Richardson (*Lancet*, 1856, part i., p. 508), this gas, inhaled into the lungs of animals, will cause death from collapse, with the characteristic symptoms of vomiting and purging. No cases have been recorded where it has been injurious to man.

VI. ARSENIC.

History.—The poisonous properties of this element, which is by far the best known and most important of all the mineral poisons, have been recognized from the earliest ages of chemistry. The name is first mentioned by Dioscorides Pedanius, a physician of Cilicia, who published a celebrated book on *materia medica*, about the beginning of the second century A.D. He speaks of arsenikon, or auri pigmentum, as a yellow or golden mineral, coming from Mysia or from Pontus, with poisonous and astringent properties, "making sores, burning violently, eating away the hair." Later, in his book on poisons, "Περὶ Δηλητηρίων Φαρμάκων," he states how the same mineral taken internally "gives violent pains in the stomach and intestines, corroding them fiercely. Hence they must take something, as soon as possible, to mitigate the burning and to produce smooth and easy vomiting." He mentions as antidotes the juice of the mallow, decoction of linseed, milk, and other soothing beverages.

The above evidently refers to the yellow sulphide, As_2S_3, orpiment, a not uncommon mineral, which can be easily purified, as Dioscorides mentioned, by gentle calcination.

It was probably not long after this that the white arsenic, arsenicum sublimatum, was discovered, for it is mentioned by Geber in the ninth century, and in the early middle ages we find it already an article of commerce, well known for its poisonous properties.

One of the earliest arsenic cases on record is carefully recorded in the French archives under the date of 1384. A wandering minstrel, called Wondreton, was arrested in Paris for trying to poison King Charles VI. of France, his brother the Duke of Valois, and the Dukes of Berri, Burgundy, and Bourbon. During the trial, under the stimulus of torture, he confessed that he had received detailed instructions for the crime from Charles the Bad, King of Navarre. He was told that there was a white powder, arsenicum sublimatum, to be found at the apothecary shops in Pampeluna, Bordeaux, Bayonne, and all the large towns through which he would travel. "If a man eats from it a piece as large as a pea he will never live. Take it and put it into their soups, wine, or meat, wherever it can be done in safety." It is pleasant to learn that this early attempt proved abortive, and that the troubadour was duly executed.

From that time on, arsenic seems to have been a favorite agent for secret poisoning. In a celebrated English case in 1618 Sir Thomas Overbury, secretary to King James I., died of slow poisoning in the Tower, at the hands of Lord Rochester and his wife, the infamous Lady

Essex. Upon the trial it appeared that arsenic and cantharides had first been employed, but as the victim proved unusually resistant, aqua fortis, mercury, powdered diamonds, lunar caustic, and "a great spider" had also been administered, and he was finally killed by a strong dose of corrosive sublimate.

The most wholesale poisoning, however, which the world ever saw took place in Europe from the middle of the seventeenth to the beginning of the eighteenth century, when three women, Tophania in Naples, Spera in Rome, and the beautiful Marquise de Brinvilliers in Paris, distinguished themselves above their fellows by the skillful use of slow poisons. The stories told of this time seem really incredible. It is stated that the strength of the drugs was so proportioned as to kill the victim in a week, a month, or a year, with perfect surety, and without any remarkable symptoms. The most celebrated of the three, La Tophania, is believed to have killed over six hundred persons, and used to send her drops, the aqua tophana, all over Italy to her clients, among the fashionable women of the day. In some cases, it is said, when the wives who wished to rid themselves of their husbands were too poor to buy the medicine, she used to send them vials of it gratis. A letter to Hoffman, in 1718, from Gavelli, physician to the Emperor Charles VI., states that the drops were composed of crystallized arsenic dissolved in water distilled with the herb *Linaria cymbalaria*.

In those days, and, indeed, well up to the early part of this century, it was impossible to distinguish arsenic, with any certainty, in the bodies of patients, or even in the drugs themselves. But after Orfila, Reinsch, Marsh, and others had made their famous researches on the subject, it gradually became understood that of all poisons arsenic was the one most easily and surely recognized by chemical tests. And yet, even up to the present day, owing to its wide distribution, its cheapness, its lack of taste, the similarity of its symptoms with those of ordinary diseases, and the widespread knowledge of its powers and properties, arsenic is still used, and used probably, far more generally than is supposed, for criminal poisoning, as well as for suicides.

We may even boast, in our own country, of having furnished individuals, in the last few years, who would not be unfit companions for the worthies mentioned above. Mrs. Sherman, for instance, in New Haven, disposed of three husbands, and some seven or eight children, stepchildren and others, without suspicion, and was only caught, by accident, on the death of husband number four. While Mrs. Robinson, at Somerville, Mass., from February, 1885, to August, 1886, poisoned no less than six members of her immediate family, besides at least two or three more on previous occasions, and she was only suspected on the last case.

This seems to throw rather a slur upon the state of medical science in these two localities; but it is not a very easy matter to distinguish the symptoms of arsenic poisoning. And while the Sherman woman carefully selected rather old and inferior physicians to attend her victims, Mrs. Robinson adopted a far more bold and ingenious plan. She waited until her relatives were sick of some well-defined disease, and had them treated by the best physicians in Massachusetts; and after these had made a satisfactory diagnosis, she would kill them off rapidly, with arsenic, before the time of the next visit. The first woman was caught by the accidental summoning of a bright young doctor, who at

once recognized the case; while the physician who attended Mrs. Robinson's last son thought it strange that a blow in the back of the neck should have such unusual sequelæ, and ordered an autopsy.

Modern Statistics.—At present, however, the cases of arsenic poisoning are not as abundant as might be imagined. In the famous Maybrick trial, Dr. Tidy, for the defense, claimed, without much contradiction in court, that the symptoms of arsenic poisoning were so varied because there were so very many cases of it known and studied. Dr. Stevenson, who appeared for the crown, looked the matter up after the trial, and found that, as a matter of fact, this was not the case. In the five volumes of the reports of the Registrar-General of England, from 1883 to 1887 inclusive, he collected the following statistics. (*Guy's Hospital Reports*, 1889, p. 307.)

DEATHS FROM POISONING (1883 TO 1887 INCLUSIVE) IN ENGLAND AND WALES.

Opium	646	Phosphorus and matches	71
Lead	437	Alcohol	66
Carbolic acid	332	Chloral	52
Prussic acid	132	ARSENIC	51
Oxalic acid	120	Sulphuric acid	49
Strychnine	106	Ammonic hydrate	45
Vermin-killer	59	Nitric acid	29
Hydrochloric acid	90	Mercury and its salts	26
Potassic cyanide	74		

Average cases of arsenic per year, 10.2.

In this country, where the sale of arsenic is not attended with nearly so many precautions, and where Paris green and "Rough on Rats" are articles of such common use, cases of arsenic poisoning, especially for suicidal purposes, are more frequent.

In the Forty-sixth Annual Registration Report of Massachusetts, published by the secretary of the commonwealth (1888, p. 412), there is found a list showing the deaths from arsenic in Massachusetts from 1877 to 1887 inclusive:

DEATHS FROM ARSENICAL POISONING.

Years.	*Homicidal.*	*Suicidal.*	*Accidental.*	*Total.*
1877, six months	..	2	..	2
1878	..	2	1	3
1879	..	6	..	6
1880	2	3	2	7
1881	..	3	..	3
1882	..	2	..	2
1883	..	3	1	4
1884	..	16	..	16
1885	..	12	1	13
1886	6*	14	2	22
1887	1	35	..	36
	9	98	7	114

In a New York City Board of Health report for 1892 are published some interesting statistics, which tell much the same story.

The cases of homicide are not given, but the accidental deaths for

* Robinson cases, recorded in year when investigation was made.

twenty-one years and the cases of suicide for the year 1891 are reported in much detail.

Accidental Deaths in New York City from 1870 to 1891 inclusive.

Illuminating-gas (of which 266 were from 1880 to 1891 inclusive)	279	Oxalic acid	14
Opium, morphine, etc	179	Ether	11
Lead	113	Potash	8
Carbolic acid	58	Aconite	8
ARSENIC and its compounds	42	Potassic chlorate	7
Chloroform	34	Muriatic acid	6
Chloral	26	Nitric acid	6
Mercury	19	Phosphorus	6
Coal gas	14	Minor poisons	27
Total number of deaths	977		

In this table arsenic stands far higher in the list than it does in England, while the next table, that of suicides, shows the same astonishing state of things as in Boston.

Suicides in New York City for the Year 1891.

Gunshot	104	Carbolic acid	9
Hanging	50	Drowning	9
ARSENIC { Paris green ....20; Rough on rats..12; White arsenic .. 3 }	35	Prussic acid and potassic cyanide (each, 3)	6
		Chloroform	3
Cuts and stabs	24	Strangulation	3
Falls and leaps	22	Aconite (?), ammonia, belladonna, corrosive sublimate, ether, muriatic acid (each, 1)	6
Illuminating-gas	19		
Morphine and opium (each, 5)	10		
Total number of suicides	300		

It is difficult, on comparing these figures with the English statistics, not to believe that there are far too few restrictions upon the sale of arsenic in this country. Surely the number of suicides alone from arsenic in one city like New York, or one State like Massachusetts, ought not to be three or four times as many as all the cases in England and Wales. Indeed, some stringent legislation on the subject was passed in Massachusetts the year of the above report.

Occurrence in Nature.—Arsenic is found to some extent in a free state, as a black metallic solid. It is more frequently, however, extracted from some of many minerals, in which it occurs combined with metals such as iron, copper, cobalt, and nickel, or with sulphur. The most important ore of arsenic is the arsenical iron pyrite, or mispickel, $FeAsS$, but the arsenides of iron and of cobalt are also quite common. The latter, indeed, is often powdered and sold in bulk, as a fly poison, under the name of "cobalt."

The two sulphides of arsenic, orpiment, As_2S_3, and realgar, As_2S_2, are not uncommon minerals, and we also occasionally find in nature small quantities of arsenious acid, As_2O_3, and of arseniates.

Besides this, arsenic in small quantities is distributed very widely. As a common impurity of iron pyrites it occurs in many soils, generally in an insoluble state, and, being also found in sulphur, it is present in almost all samples of oil of vitriol, and of the many compounds—hydro-

chloric acid, bleaching powder, sulphates, carbonates, and hydrates of soda and potash, and the like—prepared by its use. From the sulphuric acid it also finds its way into the various superphosphates and other artificial manures, and hence into plants; so that arsenic has been discovered in turnips, cabbages, potatoes, and other common vegetables, as well as in straw, wood, and charcoal.

From its association with pyrite it is not at all uncommon to find arsenic in coal, in quantities running as high as fifteen or twenty grains to the pound. This arsenic is of course volatilized on burning, and again appears in the smoke and soot.

Arsenic is also a common impurity in many metals and metallic salts. It is difficult to get zinc perfectly free from all traces of it, and it is frequently found, sometimes in comparatively large quantities, associated with antimony and bismuth, as, for instance, in common drugs like tartar emetic and bismuth subnitrate. Of course, in all these cases it never occurs as crystallized white arsenic.

It is present in small quantities in sea-water, and is frequently found, sometimes to a medicinal extent, in mineral waters. Thus it has been traced in practically all the iron or chalybeate springs, both of this country and abroad, and has been found in the celebrated waters of Vichy, Ems, Wiesbaden, Pyrmont, Ripoldsau, Carlsbad, and others. Among the most famous arsenical springs are those of Bourboule, in France, and of Roncegno, in the Southern Tyrol, in which last water Gläser and Kalmann (*Berichte*, vol. xxi., 1888, pp. 1637, 2879) found nearly nine and a half grains of arsenic acid (equivalent to over seven grains of white arsenic) to the gallon. In this country some interesting arsenical springs have been found in the Yellowstone Park, the water from the Hygeia Spring, for instance, which is much used for bathing, containing about one fifth of a grain of white arsenic to the gallon (A. Hague, 1885).

Arsenic in Graveyards.—The arsenic naturally present in the soil is almost always combined with iron, in such an insoluble form that hot concentrated acids are necessary to separate it. In several instances, bodies have been buried for months in an arsenical soil, even in wet weather, and no trace of arsenic has penetrated the corpse. (See Sonnenschein, *Gerichtl. Chemie*, 1881, p. 139.) These cases occurred, however, when the system of arsenical embalming, now so common in the United States, was either prohibited or unknown. And at present the graveyards are so filled with *soluble* salts of arsenic, from this cause, that post-mortem absorption in this way must be considered as quite possible, if not indeed probable, in many cases. It was claimed at one time, by as good an authority as Orfila, that arsenic was a normal constituent of the body. This, however, has been completely disproved.

Occurrence in the Arts.—Besides the cases above mentioned of sulphuric acid and its compounds, where arsenic is accidentally present in substances largely used for manufacturing purposes, there are many special ways in which arsenic, more or less disguised, is widely distributed and freely used.

In Medicine.—Arsenic is usually prescribed by regular practitioners in the form of Fowler's solution, a one-percent. solution of white arsenic in potassium bicarbonate. Occasionally the arsenates of soda and potash are used for the same purposes (Brett's and Pierson's solutions). But,

leaving aside the numerous quack medicines, which vary from the "complexion wafers," containing infinitesimal traces of arsenic, to the blisters of almost pure arsenious acid which have been used, with oftentimes such fatal results, by the "cancer doctors," we also find in the catalogues of nearly all the manufacturing chemists many varieties of arsenic-containing pills, under the most varied names. The amount of arsenic in these pills varies, as a rule, from one twentieth to one thirtieth of a grain, and it is generally combined with either iron, strychnine, or quinine, so as to act, as far as possible, as a general tonic, a nerve tonic, or as an antidote to malaria.

As a Household Poison.—The amount of arsenic compounds sold and used for this purpose is enormous. "Rough on Rats" is the most common, and consists practically of pure arsenious acid. It is very commonly used, especially in cities, for committing suicide; while occasionally murders, and frequently accidents, are reported from its use.

Paris green, or aceto-arsenite of copper, known to chemists as Schweinfurth green, is in frequent use not only on potato and tomato vines, but also on fruit trees and different kinds of plants and vegetables, to rid them of noxious insects. Its bright color is the best safeguard against accidental poisoning, which is largely confined to cattle and stock feeding upon the poisoned plants. It is, however, constantly used for suicide.

London purple, a waste product from the aniline factories, containing some forty percent. of white arsenic, is also largely employed instead of Paris green.

As a fly poison, metallic arsenic slightly oxidized, powdered "cobalt," and papers steeped in solutions of arsenic or of alkaline arsenites, are widely sold. These have served as a source of poison in many cases.

Arsenic soaps, consisting of white arsenic, alkali, and soft-soap boiled down together, are in common use on sheep farms to rid the animals of lice and similar vermin. They have frequently caused death by accident; in one case a whole family of five or six persons was destroyed by using drinking-water carried in a pail in which this soap had been kept.

Finally, solutions of arsenic are occasionally used, more, however, in Europe than in this country, to eradicate weeds. Indeed, only a couple of years ago, in a little Scotch village near Edinburgh, over a hundred people were seriously poisoned with sugar bought from the local grocer, which, as was afterward proved, had been in the same cargo with some leaky cans of "weed killer." (*Lancet*, 1891, part i., p. 900.)

In Paints, Wall-paper, Fabrics, etc—Arsenic is the source of many brilliant colors, as, for instance, the Paris or Schweinfurth and Scheele's greens, and also certain brilliant purple colors. These contain large quantities, often thirty percent. or forty percent. of arsenic, and, being distinctly poisonous, should be used with great care. Accidents are liable to occur from children licking these colors from the covers of books, kindergarten toys, Christmas cards, and the like. Occasionally also there may occur cases where dresses, curtains, and other fabrics, or even wall-papers, unglazed and thickly coated with such pigments, may prove injurious. These colors, however, are nowadays rarely, if at all, used in places where they might prove dangerous, and their use in wall-papers has disappeared almost entirely.

In the manufacture, however, of many of the aniline dyes arsenic

acid is frequently used for oxidation, and although almost entirely removed in subsequent operations, generally leaves traces of arsenical compounds behind. The arsenic thus left is in extremely small quantities, and as a rule can have no injurious effects; and yet such is the common prejudice against the very word arsenic that the merest trace of it is enough, in the common opinion, to cause a suspicion of poisonous properties.

A curious case of this sort came under the writer's notice in 1889 (*Swain* vs. *Schieffelin*). Nearly a hundred people in Brooklyn, one night, after indulging in ice-cream made by one confectioner, were taken with symptoms of acute irritant poisoning. Most of the cases were diagnosed as due to arsenic, and were treated as such, but some doctors withheld their diagnosis, largely on account of the rapid and complete recovery of all the cases. An inspector of the Board of Health, prowling around the ice-cream factory, came across a small bottle of a red solution, used for coloring the strawberry ice-cream, tested it for arsenic with Marsh's test, reported it full of arsenic, and held it responsible for all the symptoms. Whereupon the ice-cream manufacturer brought suit for $10,000 damages against the firm supplying the coloring matter, for selling him poisonous goods. The resulting lawsuit showed great carelessness in the manufacture of the ice-cream, and it was proved that the cream in question had been made up from some left over from a previous occasion, which had been melted up and refrozen. The symptoms, also, were evidently those corresponding to ptomaïne (tyrotoxicon) poisoning, and not to arsenic. But although the arsenic in the coloring matter was so minute in quantity that the whole bottle could have been drunk with impunity, and the dye was so powerful that only one and a half or two ounces (half a wine-glass full), containing from one thirtieth to one fiftieth of a grain of white arsenic, were used for twenty-six quarts of the cream, the intelligent jury brought a verdict against the chemical firm, and the verdict was sustained by a higher court.

(*a*) *Metallic Arsenic.*

This substance is occasionally found native in sufficient quantities and purity to be used as such, but is generally prepared by reducing the arsenious oxide with coal or charcoal.

When pure it is steel-gray in color, with a metallic luster. It is very brittle. In moist air it slowly oxidizes, and becomes dull and dark gray in color. When heated it volatilizes, without melting, with a characteristic garlic odor. At a red heat it burns with a bluish flame, emitting white fumes of arsenic acid.

It is not soluble in hydrochloric acid, but dissolves in sulphuric and nitric acids, the latter oxidizing it to arsenic acid. If this last solution is evaporated to dryness and then moistened with a strong solution of argentic nitrate, it will turn a brick-red color, owing to the formation of argentic arsenate.

It can be readily recognized by this test, and also by the fact that it is easily soluble in a hot, strong solution of bleaching powder.

A better test, however, is to put it into a narrow reducing-tube, and to heat it until it sublimes. The sublimate, which is of a steel-blue color, or when very faint is brown, can be chased, on careful heating, up

and down the tube, and, especially if a little air is admitted, can be easily turned into a white deposit of arsenious oxide, with its characteristic octahedral crystals.

Poisonous Effects.—Metallic arsenic, as such, is supposed to have no marked effects on the system, but it is readily oxidized to arsenious oxide, in which case, of course, it has the properties of that substance.

In the few cases of poisoning reported, it has been used either pure or as cobalt, a native arsenide of cobalt, powdered to serve as a fly poison, and its effects have been in every respect similar to these of arsenious oxide.

(*b*) *Arsenious Oxide*—As_2O_3.

White Arsenic, Arsenious Acid ("*Rough on Rats*").

As before mentioned, this substance has been known as a poison for many hundred years, and is indeed almost universally meant by the term arsenic.

It occurs in small quantities in nature, but is manufactured for the market in enormous quantities, by roasting and subliming arsenical ores, such as mispickel or arsenical iron pyrites, FeAsS. The fumes are condensed in a series of brick chambers, upon the walls and floor of which the arsenic collects, in large or small crystals. In some places the arsenic is caught in iron hoods placed over the roasting-furnaces. These get hot enough to melt some of the arsenic, which fuses into a thick, glassy cake, with loose layers of white crystals upon it. This last layer is chipped off of the cake by hand.

Properties, Physical and Chemical.—Arsenic is usually sold as a white, heavy powder, but occasionally as the hard solid masses of molten arsenic described above. The latter are colorless and almost transparent when fresh, but on exposure to the air soon become opaque and white, looking like porcelain, owing probably to a partial crystallization. The powder may be formed from grinding these lumps, but generally comes from grinding the crystals, which are octahedral and vary greatly in size. Many, indeed, are quite small enough to pass the finest grindstones uncrushed, varying in size from 1–250 to 1–5000 of an inch in diameter.

Hence under the microscope it is often possible to identify a specimen of arsenic by carefully studying (*a*) the percentage of crystals, (*b*) their size and diameter, and (*c*) their surface, striations, brilliancy, etc. This was attempted, with very considerable success, by Prof. E. S. Dana, of New Haven, in the famous Mary Stannard, or Hayden, trial, where he tried to show, first, that the arsenic found in the girl's stomach was identical with that bought by Mr. Hayden a few days before; and second, that the package of arsenic claimed to have been bought by the defendant a few days before in the neighboring town, had, in fact, come from a different locality. The microscopic appearance is altered to some extent by soaking in water and other fluids, but often not enough to spoil this examination.

Arsenic is quite heavy, one teaspoonful weighing about one hundred and fifty grains, and a tablespoonful about three hundred and fifty grains, or about three fourths of an ounce. (Taylor.) It is, however, perfectly possible to suspend quite large quantities in thick liquids, like cocoa, gruel, and the like, so that its presence is not suspected.

Small doses of arsenic have no taste, but when in large doses its taste has been variously described as slightly acid, metallic, sharp, sweetish, salty, and so on. This can be entirely concealed by the taste of food or drink.

Arsenic is sparingly soluble in water, and even less so in organic liquids, like tea, milk, beer, etc. According to Taylor, cold water, allowed to stand on arsenic for many hours, dissolves from one half to three quarters of a grain to the ounce.

If the water is boiled on it for an hour and then allowed to cool, it retains some twelve grains to the ounce. The amorphous or vitreous arsenic dissolves some three times more readily in cold water, and in boiling water dissolves to the extent of fifteen or sixteen grains (Seidel in *Maschka, Gerichtl. Medecin*). Its solution is slightly acid in reaction, and deposits octahedral crystals on cooling or evaporation. Arsenic is easily soluble in both acids and alkalies, the latter forming salts of meta-arsenious acid, $HAsO_2$, or occasionally of the normal acid, H_3AsO_3. Arsenic in alkali solution tends to oxidize into the *arsenic* oxide, As_2O_5, and hence is somewhat used as a reducing agent.

It sublimes at a low red heat in the form of a white cloud, and if charcoal is present, with a garlic odor. It deposits readily in octahedral crystals.

Properties, Physiological.—In small quantities arsenic acts as a distinct tonic. It increases the appetite and the nutrition of the body. Its effects are most marked upon the stomach and intestines, but it also seems to directly benefit the blood, and to stimulate the nervous system.

It is, indeed, largely used as a medicine in a wide range of diseases. Next to quinine it is the most valuable drug for the treatment of malaria. It is largely used for dyspepsia, for a variety of skin diseases, and especially in the treatment of certain nervous diseases, like chorea, for example.

In these cases it is given, as a rule, in the form of Fowler's solution, in doses ranging from five or six drops up to sixty drops a day.

The latter dose, twenty drops three times a day, is about as high as it is safe to go, and when kept up for a long time may produce trouble. Indeed, when given medicinally, in full doses, for some time, arsenic often seems to accumulate in the body, and, when once the more marked symptoms begin to show themselves, the injurious effects often distinctly increase, for days and weeks after the drug has been discontinued.

The first injurious symptoms noticed with these full medicinal doses are usually connected with the digestion, and consist of nausea, vomiting, pain, and diarrhœa; and also with the skin, itching, eczema, conjunctivitis, and the like. These symptoms can easily develop into those of chronic poisoning, mentioned below.

Poisonous Symptoms.—When arsenic has been administered in doses large enough to endanger life the symptoms that may present themselves are very numerous. It is acknowledged by all the best authorities that arsenic symptoms present more anomalies than those of any other poison, and to insist, as is often done in a defense, notably in the case of Mrs. Maybrick, that arsenic is not the cause of death because one or two common symptoms are absent, is wholly unjustifiable. The effects of arsenic vary with the size of the dose, with its form, whether dry or in solution, with the emptiness and condition of the stomach, with the gen-

eral health and idiosyncrasy of the patients, with the treatment given to them, and many other conditions.

It must be remembered that arsenic is not only an irritant like sulphuric acid or caustic alkali, but has certain specific effects as well. Thus, in the ordinary forms of arsenic poisoning, we have symptoms of irritation and inflammation of the gastro-intestinal tract, vomiting, nausea, tenesmus, pain in the stomach and abdomen, and the like.

In other cases the arsenic seems to pass directly into the blood and thus into the cerebrum, and overwhelms the whole nervous system. The stomach symptoms may be entirely absent, and the patient fall into a heavy narcotic sleep, and die in a state of coma.

While the poison is being eliminated, a process which begins very soon after it is taken, it generally causes fatty degeneration in the liver, heart, and kidneys, the symptoms from which are often very prominent. And with these we often find an irritation of the conjunctiva, and also of the skin, with pains in the legs and lower extremities.

Finally, if the arsenic is in the system for some length of time, a week or more, we are apt to have a series of chronic nervous symptoms, due to a gradually progressing, multiple, peripheral neuritis, which may finally terminate in complete paralysis.

Accordingly we can roughly subdivide the cases of arsenical poisoning into four heads: 1. Acute; 2. Sub-acute; 3. Cerebral or narcotic; 4. Chronic.

1. Acute Cases.—As a rule, where large doses of arsenic have been taken the main action of the poison is upon the digestive tract. The first symptoms noticed are of *weakness* and *faintness*, generally in half an hour or an hour after the dose. Then comes *vomiting*, violent and incessant, a very constant symptom, beginning generally within two or three hours after the dose and continuing almost always until death. The vomited matter is partly a watery secretion, and partly a thick glairy mucus, often containing bile and sometimes streaked with blood.

Accompanying this is *dryness of mouth and throat, great thirst, and pain in the stomach*. This last is usually strongly marked, and is a sensation of burning. Next comes *diarrhœa*, a less constant symptom, which is absent, or comes very late, in many well-marked cases. It is usually accompanied with a good deal of tenesmus. The discharges are generally yellowish, and very loose, often of the rice-water type, and occasionally bloody. The urine is usually scanty, of a dark red color, and is sometimes entirely suppressed.

After these symptoms have lasted a greater or less time there are signs of *collapse*. The pulse gets quick and feeble, the face white and sunken, the eyes deep, the lips blue, the skin cold and clammy, often covered with a cold sweat, and the patient dies sometimes in convulsions and sometimes in coma.

These cases usually die rapidly, in six to twelve hours as a rule, certainly in less than twenty-four hours, and the cause of death seems to be the shock from the intense inflammation of the stomach and intestines. Some of the cases are a good deal like cases of cholera.

2. Sub-acute.—If the dose of arsenic is smaller, or the excess of the poison is eliminated quickly by vomiting, antidotes, and the like, the above symptoms may be less strongly marked, may come on more slowly, and continue longer.

In these cases the vomiting is the most consistent and constant symptom, and the stomach and abdomen are usually distended and very tender. All of the above-mentioned symptoms of inflammation of the digestive tract are or may be present, but in addition we have the signs of inflammation of the liver and kidneys. Arsenic is eliminated by these organs in a very short time, that is, two to four hours after its ingestion, and if in large quantities, almost invariably sets up acute inflammatory changes, with fatty infiltration. This change in the kidneys is indicated by scanty, high-colored urine, containing albumen, casts, and occasionally blood.

The skin, which is hot and dry in long-continued cases, often gets covered with a rash; the tongue is cracked and dry; the lips and gums are often inflamed and bleed easily; the patients are more or less jaundiced, and the eyes become yellow, with congested conjunctivæ. The patients often complain of pains in the legs and thighs. Death, which occurs in two or three days or even later, is, as before, generally from collapse, and is preceded by prostration and then coma, or by delirium.

Appearance of First Symptoms.—The first signs of poisoning, such as faintness and nausea, usually appear pretty rapidly, i.e., within an hour after taking the poison. Cases are on record where the symptoms came on in the act of eating poisoned food. On the other hand, even when large doses have been taken well-marked symptoms have been delayed for many hours.

This seems due, in some cases, to the arsenic being mixed with food and hence not being easily absorbed, and in some cases to the action of sleep, or the use of morphine or of alcohol. In most of these cases the later symptoms belonged to the narcotic type.

In one case (*Med. Gaz.*, 1851, vol. vii., p. 722) a strong, healthy man, while drinking, took half an ounce of arsenic in a glass of beer, washing the poison down with some water. He vomited once in an hour or so, and then lay down and slept till the next morning, when, about nine hours after taking the poison, the characteristic symptoms of vomiting, thirst, pain in the abdomen, etc., appeared. His brother, who slept in the same bed, considered his sickness was caused by his drink, and did not learn of the arsenic until noon. The man died in about three days.

In another case (Hartshorn, *Phila. Med. Exam.*, 1855, vol. xi., p. 707), where the symptoms were delayed for sixteen hours, a girl took a dose of powdered arsenic at 9 P.M. and another at 9 A.M. the next morning. About eleven o'clock she had hysteria, but no evidences of an irritant poison, and they gave her water, the first she had taken for thirty-six hours. At 1 P.M. there appeared violent pain and vomiting.

In still another case (*Lond. Med. Times*, 1849, vol. xix., p. 26), no marked symptoms occurred for twenty-three hours; but there were suspicions that the patient was under the influence of morphine at the time.

Time of Death.—This varies greatly, but, as a rule, takes place in less than twenty-four hours when large doses have been taken.

Out of twenty-nine recent cases in Massachusetts, quoted by Dr. Abbot (*Boston Med. and Surg. Jour.*, 1889, vol. cxx., p. 480), the longest lasted six days and the shortest six hours, while the average time was sixteen hours. The average of the rest, leaving out the six-day case, was about eleven hours.

The shortest time on record is given by Dr. Taylor as twenty min-

utes, and in another case (Von Tschudi, *Wien. Med. Wochensch.*, 1851, p. 455) a peasant is stated to have taken a small lump of arsenic, mixed with water, and died in half an hour. These rapid cases, as, for instance, the one quoted below, where death occurred in an hour, are usually of the cerebral or narcotic type; but Taylor gives an interesting case (*Guy's Hospital Reports*, 1851, p. 183), where a woman took a teaspoonful of powdered arsenic, with a little water, on an empty stomach; had vomited thoroughly and was suffering great pain when the doctor saw her in an hour and a half; and, in spite of treatment, died of collapse in two hours and a half.

Death may be delayed for quite a time after the administration of the poison. Cases of death in six and seven days are not at all uncommon, and patients have been known to linger for weeks or even months, and still die from the effect of the arsenic, either upon the digestion or, secondarily, upon the liver and kidneys.

A famous case, often quoted, is that of Dr. Alexander (*Med. Times and Gaz.*, 1857, p. 389), a prominent Irish clergyman, who was given some arrowroot in which the grocer had carelessly mixed arsenic. In spite of prompt treatment he died in sixteen days, and on the trial of the grocer for manslaughter it was proved that his death was due directly to the poison, although not a trace of poison could be found in the body.

Illustrative Cases.—Dr. Taylor quotes an interesting example of subacute arsenical poisoning in the case of some three hundred and forty children in an industrial school near London, who were given milk diluted with water from a boiler containing a solution of arsenic. The amount of arsenic taken by each child was about a grain, and the symptoms, shivering, pain in the stomach, and, in most cases, vomiting, developed within an hour. In about three hours after the meal they had more or less severe pain in the forehead and watery running of the nose. Seven had a croupy sort of cough, three vomited blood, and one passed blood by the bowels. Some had distinct gastritis; but as the cause of sickness was speedily recognized, and treatment was applied at once, all recovered, and only six were being treated at the end of a week. The treatment consisted of giving gum-water with albumen, and of keeping up vomiting by emetics and greasy water for twelve hours, finishing with doses of castor-oil.

A famous example of one of these cases was that of the Duc de Choiseul Praslin, who, when arrested after brutally and clumsily murdering his wife, poisoned himself with a large dose of arsenic. The story goes that the clever and ingenious French detectives, before taking him to prison, searched him and his clothes thoroughly from head to foot. They finally made him change his coat and put on a dressing-gown, in the pocket of which there happened to be, unknown to them, a package of arsenic, which he had bought some time previously, probably for his wife's benefit. He took this, and in a few hours began to vomit violently. He had no diarrhœa, except an involuntary movement on the second day, had no conjunctivitis, no cramps, no pain in his abdomen until the fourth day, probably owing to his having been given some morphine early in the attack.

His doctors, the best in Paris, were much bothered, diagnosed it for the first two days as cholera, and then as laudanum poisoning, and

finally found out the true cause by analyzing the ejecta. He died of collapse on the sixth day.

An interesting series of cases of this class is reported by Dr. Stevenson (*Guy's Hospital Reports*, 1875, vol. xx., p. 145), where eight persons in one family were poisoned by drinking water kept in a pail which had been used for an arsenical sheep-wash. Five of these died, in six, seven, twelve, thirteen, and thirteen days respectively from the time of the fatal dose. Of the eight patients, all had persistent and violent vomiting; only four (three of whom died) had diarrhœa, seven had conjunctivitis, and five had a rash or eruption on the skin.

3. Cerebral or Narcotic.—In these cases the signs of gastric or intestinal irritation are almost entirely absent. The principal symptoms are great feebleness, with a weak pulse and cold skin, dizziness and pallor, and cold extremities. The patients generally sink into a heavy narcotic sleep, from which they cannot be roused, and die in a state of coma. Sometimes they may remain conscious, although sinking, until near the end, and die in a state of collapse, occasionally with convulsions.

These cases are not very commonly met with, and usually are due to the rapid absorption of the poison, which has either been taken in solution, or, if dry, in large quantities on an empty stomach.

The time of death in these cases is usually quite short. These patients rarely survive twenty-four hours, and have been known to die very rapidly indeed.

Death in One Hour.—One of the most rapid cases ever reported is given by Dr. Finley (*Lancet*, 1883, part ii., p. 943). A healthy man, aged fifty-one, had drunk by mistake, upon an empty stomach, a solution containing about twenty-six grains of arsenic. He was taken almost at once with faintness and collapse, with some epigastric pains. He was brought to the hospital in about half an hour, and had not yet vomited.

His symptoms were cold skin, a free, clammy sweat, feeble, slow pulse, shallow respiration, pupils moderately dilated. He was still conscious, and complained of headache, constriction across the chest, and pain in the epigastrium. Emetics did not work; they washed out the stomach, but without effect. He was put to bed, given brandy, hot-water bottles, warm blankets, and the rest; but in spite of everything he sank rapidly, became pulseless, and died in one hour from the time he took the poison.

Post-mortem examination showed intense congestion of the mucous membrane of the stomach, with some congestion of the trachea and larynx. The intestines, spleen, and heart were normal, except for an ecchymosis on the endocardium of the left ventricle. The liver and kidneys were congested, and arsenic was found in the contents of the stomach, the tissues, and in the liquid remaining in the bottom of the bottle.

In another case (*Edin. Med. Jour.*, 1843, vol. lix., p. 350) a girl, aged twenty, took some two ounces of dry arsenic on an empty stomach, and although she vomited soon, died in two hours and a half from collapse.

These cases do not always terminate rapidly. For instance, Dr. Willard (*Maryland Med. Jour.*, 1885, vol. xii., p. 333) gives an instance of a healthy girl, twenty-three years old, who took a teaspoonful of "Rough on Rats," dissolved in tea, just after midnight. Soon afterward she vomited and fainted, and she was found next morning unconscious, with

symptoms of extreme pallor and weak, rapid pulse. Vomiting was induced by zinc sulphate, and at two o'clock in the afternoon she recovered consciousness. She complained of a dryness of the throat but no pain, and was weak and sleepy. Her stupor increased, and she died comatose at about three o'clock, fifteen hours after the fatal dose. On post-mortem examination her stomach was found to be much inflamed.

4. **Chronic Cases.**—The previous symptoms all had reference (*a*) to the local irritation of the digestive tract, (*b*) to the later lesions of the liver and kidney, and (*c*) to an overwhelming effect on the central nervous system.

We now come to a class of cases where the symptoms are chiefly due to lesions of the nerve fibers themselves, resulting frequently in almost complete paralysis.

These effects of arsenic have been known for a long time. Peter Abano, for instance, in the thirteenth century, states in his treatise *De Venenis Eorumque Remediis* that "whoever gets realgar in his drink suffers thirst and heat and drought, and is either cured, or dies, or remains paralyzed and contracted." He further quotes a case of such paralysis. Ambroise Paré and other writers of the sixteenth century fully confirmed his statement. And yet in recent times these symptoms have been largely overlooked, and have only been brought into prominence in the last ten years.

These symptoms occur in two different sets of cases: that is, in patients who are recovering from the effects of an acute or sub-acute attack, or else in cases where the poison has been administered for some time in comparatively small doses.

These latter are not uncommonly met with in practice, from the excessive use of arsenic as a medicine. This rarely happens with careful treatment. The head of one of the New York nerve clinics told me that out of several hundred patients who had been treated, in his clinical practice, with full doses of Fowler's solution, two cases only had suffered from the effects of arsenic. These two, however, had by some carelessness of his assistants become almost completely paralyzed.

Dr. Dana (*Brain*, 1887, vol. ix., p. 456) tells of a man aged forty-eight who had been suffering with chronic gastralgia for twenty-eight years, and finally was treated, at Bellevue, with Fowler's solution in gradually increasing doses. After two months the dose reached thirty drops of Fowler's solution three times a day, or nine tenths of a grain of arsenic per diem. This lasted for nearly a month, when nervous symptoms came on, and resulted in complete paralysis.

Another similar case is given by Roucher and Brouardel (*Ann. d'Hyg.*, 1874, vol. xlii., p. 406), when similar disturbances resulted from a much milder course of arsenic. A girl, twenty-two years old, suffering with persistent eczema, was given Fowler's solution for the first fortnight at the rate of thirty drops (three tenths of a grain of arsenic) per day, and for two weeks more at the rate of forty drops (four tenths of a grain of arsenic) per day. She began the fifth week with twenty drops three times per day, but after one day went back to forty drops, and then in a day or two stopped the treatment. Nervous symptoms came on almost at once, resulting in marked paralysis at the end of five or six weeks.

But besides these and other isolated cases, there have been of late

years two well-defined epidemics of chronic arsenic poisoning, which have been thoroughly studied by the best French physicians, and from which the symptoms of this disease have been clearly defined.

In one case some four hundred and thirty-five people, in the village of Hyères, were poisoned by wine containing from about one sixth to two and a half grains of arsenic to the quart. The sickness was at first thought to be "mucus fever," then grippe, and, when five or six old people had died from it, and almost every family in the neighborhood was suffering from it, the illness was at last traced to the wine from a neighboring vineyard. There was naturally great excitement; the proprietor was accused of having intentionally poisoned his wine, and was thrown into prison. But it appeared, on investigation, that the trouble was all due to an accident, a barrel of white arsenic having been mixed in with the plaster, which was applied in small quantities to the grapes before pressing.

The other case, which although it involved fewer people was still more curious, is reported in full in the *Annales d'Hygiene* (1889, vol. xxii., p. 36) and elsewhere. In July, 1888, a civil suit was commenced in Havre against the owner of a small apartment-house, with a pharmacy on the ground floor, on account of the unsanitary condition of the premises. In accordance with the excellent French custom, a commission of four of the best doctors in France, Messrs. Brouardel, Delaunay, Huchon, and Pouchet, came down from Paris to investigate. They examined thoroughly the drainage, plumbing, soil, wall-papers, etc., studied carefully the symptoms of the invalids, and after a complete investigation, aided largely by the results of the Hyères epidemic, decided that the illness came from small doses of arsenic.

This started the authorities on a new track, and it was soon found that a young clerk, Pastré Beaussier, employed in the drug-store, had, from pique, fear of dismissal, and other reasons, amused himself by poisoning first his employer and then his fellow-clerks and servants. He had reached, at the time this was found out, in the space of barely two years, the respectable tale of fifteen victims, three of whom died, and the rest of whom were more or less completely paralyzed.

The symptoms of the Havre and the Hyères cases were the same, and may serve as a model for all cases of chronic arsenic poisoning.

(*a*) *Trouble with the Digestion.*—The patients would first notice a feeling of sickness and nausea, which increased, almost always, to actual vomiting. This vomiting was quite characteristic; it was not painful, nor did it leave pain or a burning feeling in the stomach; it was quite frequent, running up often to seven or eight times a day; the vomited matter was full of mucus and bile. Occasionally, however, it occurred only two or three times during the illness.

Sometimes the patients became quite feverish, with some typhoid symptoms. Intestinal troubles were less marked, and lasted, as a rule, but a short time.

(*b*) *Symptoms in Larynx and Bronchi, Skin Symptoms.*—After some little time the patients developed decided symptoms of a catarrhal inflammation of the larynx and bronchi. They suffered from coughing, spitting of mucus and occasionally of blood, loss of voice, with sibilant and sonorous râles in the bronchi. Indeed, at Hyères, the doctors at this stage diagnosed the illness as grippe, and prescribed accordingly.

Accompanying this was intense coryza, with inflammation and running of the nose, often spreading to the eyes and producing more or less marked conjunctivitis.

With, or before, these catarrhal symptoms there developed a cutaneous eruption, beginning with redness and swelling of the eyelids, the scrotum, and then of different parts of the body. This was often followed with exfoliations and by loss of the nails. The eruptions varied greatly, being vesicular, pustular, sometimes rubeolic, or like urticaria. The surface of the skin was more or less pigmented, frequently becoming a dirty brown color, especially on the neck, the rump, and the extremities, and also in the armpits, under the knees, and around the anus. In autopsies arsenic was found in the skin, nails, and hair, and it is claimed that these symptoms may have been caused by the elimination of the poison in that way.

(*c*) *Disturbances of Sensation.*—Next to these symptoms there came more or less marked trouble with the nervous system. This began with headaches, severe and persistent, over the whole head, and an unpleasant numbness in the legs and feet. One of the fellow-clerks of Pastré Beaussier testified that he used to keep hitting the soles of his feet, behind the counter, with a spatula, to try to keep up the circulation. This numbness was often accompanied with painful cramps.

Then came extreme pain, sometimes shooting, more often grinding, situated chiefly in the calves and thighs. The patients complained of dogs biting the calves and the soles of their feet. There was an increased sensibility of the skin; a child complained of butterflies running up and down his back. In almost all of the cases the pressure of the bedclothes became unendurable.

There was some loss of general sensation in hands and feet. It was hard to feel the ground or to hold small objects. In almost all cases there was an anaphrodisia.

(*d*) *Disturbances of Motion.*—In every case the disturbances of sensation preceded those of motion, and in light cases the latter were hardly perceptible. In the severe cases, however, they gradually increased to almost complete paralysis.

They began with some muscular weakness, first noticed in the legs. The patients were easily fatigued; found it hard to mount the stairs; threw the legs out in front when they walked.

Then they lost the power of walking; they had to drag themselves along. When they stood up they had to grasp some support, or keep changing their feet all the time. The feet became flabby and hung when at rest. Similar symptoms were noticed in hands and arms, the "wrist-drop" usually appearing after the "foot-drop." The tendinous reflexes were constantly, and the cutaneous reflexes generally, absent. The plantar reflex was feeble, but still existed in many cases. The cremaster and abdominal reflexes were normal.

If treated at the onset of the paralysis, the patients usually, though slowly, recovered. But if the poisoning still continued, the paralysis became more and more complete, and the patients died usually of dyspnœa and syncope, from heart failure, though without any decided lesions.

Death sometimes resulted from fatty degeneration of the liver and kidney, caused by the elimination of the poison.

Chronic Symptoms after Large Doses.—Very similar disturbances of the sensory and motor nerves are frequently met with in patients who have recovered from the acute or sub-acute symptoms of large doses. It is supposed, in these cases, that the arsenic, slowly working out of the system, permeates it and affects it in the same way as when given for a long time.

Scolosuboff, for instance, in an important paper (*Compt. Rend. Biol.*, 1875, part ii., pp. 309, 313), gives two cases. One of these, who was a porter, who, for a syphilitic eruption, rubbed into his scrotum, arm, and nose an alcoholic solution of arsenic, and also an arsenic pomatum. He soon had vomiting and gave up this treatment; but in two weeks entered the hospital suffering from numbness and tingling in his hands and feet, and great muscular feebleness. In spite of careful treatment his symptoms got worse for ten or twelve months, after which he began to improve.

His second case, which is more characteristic, was of a woman forty-eight years old, who took a dose of arsenic instead of chalk, and began to vomit in one hour, keeping up the vomiting constantly for forty-eight hours. In four or five days she noticed a feeling of cold and numbness at the ends of her fingers and toes. Then the cold reached her forearms and legs, and she had great feebleness in her hands and feet. In ten days she could not walk without assistance, and in fifteen days she took to bed permanently, almost completely paralyzed.

Dr. Miles (*Phila. Med. News*, 1883, vol. xlii., p. 257) quotes a similar case of a lawyer, twenty-four years old, who with six other people, of whom two died, ate some pie accidentally poisoned with arsenic. He vomited soon after eating, and after some hours vomited incessantly all night long. This subsided in three days, leaving him much prostrated. His bowels did not move. In four or five days he had marked fever, and in six days he noticed aching and numbness about his knees and then his feet. In nine days he noticed numbness in his fingers and hands, as far as the wrist, with loss of power in his forearms; while his legs, at this time, from the knees down, were almost completely paralyzed. His face was puffed and swollen. In four weeks he had severe pain from the knees down, and a little later in his hands and fingers. The symptoms got worse for two or three months, and then gradually improved under treatment.

A typical case of this sort was seen by the writer recently (November, 1893), in the person of a German clerk, thirty-nine years old, of good history and previous health, who in November, 1892, took five cents' worth (a big tablespoonful) of Paris green. In three quarters of an hour he vomited and felt severe pain in the abdomen, and, after being without treatment for three days, went to the Presbyterian Hospital. Two weeks later he lost sensation, more or less completely, in the legs and forearms, and soon afterward began to lose power in the legs and hands. The sensation returned in about six weeks more, but the loss of power became worse up to some three months and a half from the time of taking the poison, after which he very slowly improved. He never lost power completely, though quite unable to walk or to use his hands or forearms. In April he had a macular eruption all over his body, which was cured by sulphur ointment.

In April he was removed to Bellevue, where under careful treatment he slowly improved, the hands recovering quicker than the feet. In

about eleven months he began to recover the use of his legs, and in November, after one year's illness, he was just able to move around on crutches, after being assisted out of his chair.

Lesions Peculiar to these Symptoms.—It has been claimed by Seguin (*Jour. Nervous and Mental Diseases*, 1882, vol. ix., p. 665) and others that these peculiar nervous symptoms are due to an affection of the spinal cord, of the nature of a diffused myelitis. It is, however, generally agreed at present, by the best authorities (see Rouchet, *Ann. d'Hyg.*, 1874, vol. xlii., p. 406; Starr, *Med. News*, 1887, vol. l., p. 173; and others), that the symptoms are caused by a general peripheral neuritis, an actual degeneration of the nerve fibers themselves, progressing from the extremities toward the cord.

These lesions are very similar to those produced by *lead poisoning* and by *chronic alcoholism*, and it is often quite hard to distinguish between them.

The lead paralysis can usually be diagnosed, first, by beginning, as a rule, in the hands and arms before the feet and legs, the "wrist-drop," for instance, occurring before the feet are affected at all; and secondly, by the almost constant presence of the "lead line," the bluish-black line along the gums.

It is usually stated that the alcoholic paralysis must be recognized by the history. In this connection it is well to remember that the nerve lesions are caused not so much by the excessive, as by the chronic, use of alcohol. For instance, a friend of mine told me of a patient of his, a woman of good family and position, brought in by her sisters for treatment of partial paralysis. Her symptoms were due to the modest dose of two milk-punches a day, taken for five or six weeks at a time, at a physician's advice, because she had become worn out by attendance at a sick-bed. It is also worth remembering that alcohol produces these symptoms more commonly in women than in men.

Another point in the diagnosis is the fact that in arsenic paralysis the mind is usually unimpaired, while in alcoholic and sometimes in lead paralysis there are marked mental delusions. The peculiar delusion considered characteristic of alcohol is the "time and place aphasia." The patients cannot judge how long they have been talking, how long they have been in the office; cannot tell what room they are in, will agree when told that they are in a strange city, and the like, although in other respects they may be perfectly sound in mind.

A rather striking case, showing how good physicians may be misled in dealing with such cases, occurred in Boston some few years ago (*Boston Med. and Surg. Jour.*, 1887, vol. cxvi., p. 423), and was discussed at a meeting of Massachusetts doctors.

It appeared that a young fellow, worth some $4,000,000, who was leading a rather fast career in Boston, was looked up at last by his family. They found him extremely ill at the Beacon Street house of a friend, in some of whose projects he had invested large sums of money. He was being attended by his friend, his friend's wife, and by an apothecary, but not by a physician. A good doctor was summoned, and found him almost completely paralyzed from head to foot. He had but few movements left, and had lost almost all sense of touch in his extremities, and besides this he had symptoms, severe vomiting and the like, of considerable gastric inflammation.

His vomit and urine were analyzed for arsenic with positive results (one quarter and one third of a grain of arsenic in the vomited material, one twelfth of a grain in the urine), so he was removed to another house, and, under careful treatment, slowly recovered.

It appeared that he had been on a regular spree before he was taken ill, and, in fact, had been living for some time at a house of bad repute, and had now and then been taken to Beacon Street for dinner, and back again, in a carriage. He related how, when at dinner at his friend's house, he had taken certain articles of food which always made him ill. The doctor who related this closed his story by stating that the facts had been laid before the district attorney, and that a prosecution might result.

Whereupon a distinguished doctor in the meeting informed his friends that he took a lively interest in this tale, because, a few months before, a very pleasant, gentlemanly-looking man had called him in to see a friend lying sick at his house. The patient was, as described, lying crippled with paralysis, and had symptoms of vomiting; but his friend kindly gave a full history of his previous career, and carefully explained that his condition might be due to alcohol, syphilis, diarrhœa, or malaria. The doctor did not state exactly what diagnosis he *did* make, but confessed that the idea of arsenic never entered his head.

Prognosis and Treatment.—As before stated, these patients, if treated properly and in time, usually recover, although when the paralysis has once fairly set in the treatment is long and tedious. It consists, as a rule, of nerve tonics like strychnine, of doses of salicylate of soda, of massage to try to keep up the tone of the muscles, and of wholesome and stimulating food. Morphine may have to be applied to relieve the pain.

Poisoning by External Application.—As may be noticed in one of the cases lately mentioned, the characteristic symptoms of arsenic poisoning may be produced by the application of dissolved, and also of dry, arsenic upon the skin, and upon any of the mucous surfaces. Cases of criminal poisoning have been described where arsenic was applied to the rectum and to the vagina. In these cases the poison was rapidly absorbed, and produced symptoms of gastric irritation as well as of local. The absorption is more rapid if applied upon a raw or inflamed surface, but cases are numerous where death has resulted from the application of arsenical ointment, or even of dry arsenic, upon the scalp, or upon the healthy and unbroken skin.

A well-known example of this occurred in England in 1878, when seventeen children died from dusting the skin and private parts with a violet-powder, containing some thirty-five or forty percent. of dry arsenic instead of gypsum. Several cases of severe illness, and indeed of death, have been reported, time and time again, from the efforts of quack doctors to burn out cancerous and other ulcers with white arsenic, orpiment, and other arsenical compounds, or from the careless use of arsenical soaps and washes.

In all these cases a local inflammation is invariably first observed, but this is rapidly followed by the ordinary arsenical symptoms, the arsenic, when once absorbed, showing the characteristic stomach and intestinal lesions, as well as the later effects upon the nervous system.

Dangerous and Fatal Doses of Arsenic.—The above-mentioned chronic symptoms of arsenic poisoning have sometimes occurred after

[illegible] These [illegible]

[illegible] their [illegible] the [illegible] by Dr. [illegible] six grains [illegible] analyses, obtained

[illegible] because [illegible] every impor- [illegible] the presence of small quanti- [illegible] A notable example of this

took place in the famous Maybrick trial in Liverpool, 1889. On this occasion, besides several corroborating circumstances, such as a well-proven inducement for the crime, the agreement of the symptoms and post-mortem appearance of the body with those of arsenic poison, and the consensus of all the physicians in attendance on Mr. Maybrick, some two days before his death, that he was being poisoned, there were three points of vital importance to the defense which had to be explained in order to save the defendant.

These were: first, the presence of arsenic, although in small quantities, in the liver and intestines of Mr. Maybrick; secondly, the presence of arsenic in large quantities, and in numerous forms, either in Mrs. Maybrick's room, or in articles belonging to her, or to which she had free access; thirdly, the fact that after suspicions had been aroused and food proven free from arsenic had been provided for the patient, a nurse saw Mrs. Maybrick enter her husband's room, secretly take a bottle of beef extract from the room, and bring it back and replace it in the room, in a few minutes, full of arsenic.

The defense claimed, first, that Mr. Maybrick was an arsenic eater. This was based on some rather slight evidence. There was a colored valet, who said that eight or nine years before, in Norfolk, Va., his master used to send him out for arsenic, fifty cents' worth at a time, and stir it into his beef-tea in small quantities with a spoon. There was also some evidence to show that he was a hypochondriac, and used to dose himself with all kinds of drugs, but there was no direct proof of arsenic eating in late years.

Secondly, they claimed that Mrs. Maybrick used the various solutions of arsenic, the extracts of arsenical fly-papers, and the packages of rat poison, white arsenic, and the rest, which were in her possession, as cosmetics. In fact, she stated that she had made the fly-paper extracts to remove an eruption from her face, before a ball. This was all quite unsupported by other evidence of any sort. And thirdly, Mrs. Maybrick stated on the stand that, remembering a white powder which her husband was in the habit of using, she had, at his request, put a teaspoonful of it into the beef extract. These explanations, it might be remarked, were of more effect upon the outside public than on the jury.

The writer has been able to find out only one authenticated case of arsenic eating that has been proven in court in this country or in England. Dr. Charles H. Porter, of Albany, in an interesting pamphlet published, in 1862, about various arsenic cases in which he was interested, states that in the trial of Sarah Harrington, at Delhi, Delaware County, N. Y., in March, 1861, for the murder of her husband, witnesses showed clearly that the victim, a hostler, had for years used arsenic as a medicine for horses, and had it constantly in his possession. Others swore that he frequently took it himself, and four different persons testified to seeing him take some on different occasions some years before his death. The man died after a seventeen-days illness, and some five and a half grains of arsenic were found in his body, some on his tongue, and some in the contents of his stomach, while he had been sick in bed for some time before the symptoms of arsenic poisoning appeared.

Any general habit of arsenic eating for the complexion, health, or any other purpose, is, it is believed, unknown at present in this city, New York, or in the eastern part of the United States. It is denied by the

leading physicians, especially by those working in nervous diseases, who certainly ought to know if it exists, and by the leading druggists, both wholesale and retail. An examination at several of the leading New York hospitals has brought to light only one case, of late years, that of an actress who claimed to have ruined her health by arsenic pills, but who was suffering from a cocaine, and an alcohol, habit at the same time.

Occasionally, however, a true case of arsenic eating is met with. A well-known physician stated to me positively, a little time ago, that he *knew* one woman, of the *demi-monde*, who was accustomed to take small doses of Fowler's solution for her complexion, which was unusually pink and white, and that he *believed* the same was true of one or two others.

The commonly advertised "arsenic wafers," and similar compounds for the complexion, do not, as a rule, contain more than infinitesimal traces of arsenic.

Treatment and Antidotes.—In treating a case of arsenic poisoning, the first thing to do is to remove as much as possible of the poison from the body, and next to make insoluble what remains. After this has been done the physician must try to counteract the symptoms as best he can.

It is accordingly good practice to induce thorough vomiting as soon as possible, by tickling the throat, by warm water, mustard and water, and the like, or, better, by drugs like zinc sulphate, cupric sulphate, or tartar emetic. The last drug in full doses, five or six grains, is probably best, as it acts on the bowels as well as the stomach, and thus helps to remove the poison from the intestines also. Doses of castor-oil are also valuable. These should be followed by an antidote, and then the stomach should be washed out thoroughly with a stomach-pump.

The best-known antidote for arsenic is the freshly precipitated ferric hydrate, which forms insoluble compounds with solutions of arsenious acid. This should be prepared on the spot, by mixing ferric chloride or ferric sulphate with an excess of ammonic hydrate, or, better, of sodic bicarbonate, and straining the precipitate through a handkerchief or piece of loose rag. Perhaps the best antidote is where ferric sulphate is mixed with an excess of magnesia, and the whole is taken together; for besides the value of the ferric hydrate, the magnesium sulphate thus formed has a good effect upon the bowels.

This iron precipitate is perfectly harmless and should be given in large quantities, a spoonful or so at a time, mixed with a good deal of warm water. Numerous instances are on record where, sometimes by natural means, vomiting and the like, and at other times by prompt treatment, patients have survived even very large doses, two ounces and more, of arsenic. Recovery, however, even from light doses, is slow, and often leaves troublesome chronic symptoms.

It must, moreover, be remembered that the crystals of white arsenic, and, still more, particles of Paris green, have a way of sticking fast to the mucous membrane of the stomach, and becoming embedded in, or covered by, a thick, slimy mucus, which will not be dislodged. Under these circumstances neither antidotes, emetics, nor stomach-pumps will have the slightest effect. Every hospital physician can give instances where the ferric hydrate has been given by the basinful, and the stomach washed out till long after the washing showed no sign of suspended matter, and yet a post-mortem examination would show the stomach perfectly green with the poison.

Post-mortem Appearance of the Body.—As a rule, after arsenic poisoning the body remains in a better state of preservation than is ordinary. The preservation is generally proportional to the amount of arsenic found in the body. This is not invariably the case, for Dr. Tidy reports that the bodies of two children who died, as above mentioned, from arsenical violet-powder, decomposed unusually fast.

On examining the body critically there is noticed, as a rule, nothing abnormal about the brain, lungs, spleen, or bladder. The blood is generally dark and fluid, but there are usually evidences of two distinct classes of lesions: first, an inflammation of the gastro-intestinal tract, and secondly, a fatty degeneration of the liver, heart, and kidneys.

The Stomach.—This generally shows marked traces of an inflammation of the mucus coat, even when the poison has been administered externally. Sometimes the whole interior of the stomach is covered light red or brown. In other cases there is more or less sub-mucous ecchymosis, with groups or streaks of reddish dots. Generally there are inflamed and injected patches, principally toward the pylorus. These signs of inflammation appear quite rapidly after the poison is taken, and have been found well marked in cases of two, three, four, and five hours' duration. Occasionally, especially where death has been of the narcotic or cerebral variety, the marks of inflammation may be very slight, but they are almost invariably present to a greater or less extent.

Often particles of solid poison can be found adhering to the walls of the stomach in thick, pasty, whitish-gray (or green, with Paris green) spots or patches, surrounded by a ring of brightly injected membrane. On scraping off the spots the mucus coat below is seen much inflamed, and occasionally corroded. In spite of the vomiting the stomach usually contains some thin, odorless liquid, colored brown or sometimes red, often with white masses of mucus and other solid matter floating in it.

The Intestines.—The small intestines generally present, though in a less marked degree, the same signs of inflammation as the stomach—that is, patches of red, sometimes large, sometimes small, occasionally continuous for quite a distance. The contents are fluid, often bloody, and sometimes contain the poison in lumps or sediments.

The large intestine is not inflamed excepting when the patient has survived for some days. It is generally contracted and empty, and covered with white stringy mucus.

The Tongue, Pharynx, and Œsophagus.—These occasionally show signs of more or less acute inflammation, especially where the poison has been repeatedly administered, or where the arsenic has been taken in a dry form, or has adhered more or less to the throat itself. The œsophagus, in such cases, shows patches and streaks of dull or even bright red, and sometimes has been found corroded.

We now come to an entirely different class of lesions, which has been comparatively overlooked by most of the authors and experts; that is, the evidences of fatty degeneration in the heart, liver, and kidneys. These do not appear quite as soon as the gastro-intestinal lesions, but after some hours are, when carefully looked for, almost as regular and as characteristic.

The Heart.—This organ is in normal condition if death occurs rapidly; but if life has been prolonged for some hours the walls are usually less firm, look pale and yellowish, and under the microscope show signs of

fatty degeneration. This appearance has been observed as soon as six hours after taking the poison, and has been absent in a case of ten hours, although it can almost always be found, when carefully looked for, in cases that have lasted as long as that.

Another common appearance in arsenic poisoning is ecchymosis on the muscular tissue under the endocardium. This may be found all over the interior of the heart, but is generally to be seen on the left ventricle, on the posterior wall or the intra-ventricular septum. In some cases the ecchymosis covered half the surface of the left ventricle. (*Lancet*, 1862, vol. i., p. 325.)

The Liver.—The symptoms of fatty degeneration are more marked in this organ than in any other. The arsenic is stored up in it very quickly after entering the blood, and in its efforts to excrete the poison it rapidly becomes diseased, probably undergoing an acute, parenchymatous inflammation, resulting in changes in its tissue. The organ, when death occurs after a few hours' time, is usually enlarged, more firm than usual, looking, on section, yellow, either in streaks or all over, and presents a characteristic appearance under the microscope.

The Kidneys.—These also rapidly become inflamed from the excretion of the poison, and undergo changes in the tissue, beginning with the parenchyma. They are usually found somewhat enlarged, pale and soft, and on section show a thickened cortex and a yellowish-gray color, first on the surface, and later in spots and streaks, when the fatty degeneration has affected the tubules.

It should be remembered that death, in sub-acute cases, results from the inflammation of the liver and kidneys almost as often as from the inflammation of the stomach itself. Accordingly, in cases of suspected poisoning these organs should be carefully examined, and any symptoms of fatty degeneration should be accounted for by previous history or by analysis.

TESTS FOR ARSENIC.

1. **Solid Arsenic.**—Arsenic, when in a solid state, can be easily recognized by several simple tests.

It is only slightly soluble in water, and when stirred, or even boiled in it, floats like a white film on the surface, or forms little dry masses on the top or at the bottom of the liquid. With the addition of a little alkali it is readily dissolved, without changing color, and it is soluble in both hydrochloric acid and nitric acid when heated.

More characteristic, however, is its behavior when it is sublimed, or when it is volatilized after reduction.

(*a*) *Sublimation Test.*—When white arsenic, arsenious oxide, is heated, it sublimes readily, without melting, in the form of a white cloud, and condenses in the form of octahedral crystals. This can be done before the blow-pipe, upon a piece of charcoal, in which case the arsenic is first reduced to a metallic form, which, as it oxidizes, emits the characteristic garlic odor.

When small quantities, however, are to be tested, it is best done in a small reduction-tube, one sixteenth of an inch or so in diameter and some three inches long. This tube is cleaned and dried, and the substance, in the form of a dry powder, is placed in the closed end and heated till it

sublimes, and deposits on the glass as a white cloud. This can be distinguished from similar white rings made by calomel, corrosive sublimate, ammonium salts, oxalic acid, and other compounds, first by the shape and character of the crystals, and second by its dissolving in hot nitric acid and responding to some or all of the tests mentioned later. A simple test is to evaporate the solution gently to dryness, and to touch it with a drop of strong argentic nitrate, when it will form a brick-red deposit of silver arsenate.

(*b*) *Reduction Test.*—Another and perhaps surer test is to heat the powder in a little reduction-tube with a closed end drawn to a point (Figs. 75 and 76), either mixed with some carbonaceous flux, like potassic ferrocyanide, or else with a little sliver of charcoal above it in the tube. If

Fig. 75.—Ordinary Reduction-Tube, with Charcoal Splinter.

the charcoal is heated till it glows, any white arsenic in the powder will, on heating, be reduced to metallic arsenic, which will give a garlic odor, and deposit, further up the tube, in a black or brownish ring.

This ring may be distinguished from similarly colored ones formed by mercury and cadmium salts: first, by not being globular in appearance under the microscope; second, by dissolving in a hot, strong solu-

Fig. 76.—Special Reduction-Tube, when flux is used, drawn out after mixture is inserted.

tion of bleaching powder and in hot nitric acid (the solution in the latter will respond, as above, to argentic nitrate); and third, by forming white octahedral crystals when gently heated after the end of the tube has been nipped off. The test is very delicate, responding (Wormley) to 1–10,000 of a grain of arsenic.

2. Tests for Arsenic in Pure Solutions.—Occasionally, after a compound supposed to be arsenic has been isolated by other means, it is desirable to test it by every possible means, so as to thoroughly identify it. For this purpose the following tests are sometimes useful:

(*a*) *Ammonio-Argentic Nitrate Test.*—This reagent—freshly formed by carefully adding a weak solution of ammonic hydrate to a strong solution of argentic nitrate until the brown precipitate first produced is almost entirely redissolved—when added to an aqueous solution of arsenious oxide will produce a light yellow precipitate of argentic arsenite, Ag_3AsO_3.

This precipitate readily dissolves in ammonic hydrate and in nitric, citric, and acetic acids to colorless solutions; it is insoluble in sodic and potassic hydrates. Hydrochloric acid changes it to white argentic chloride.

The test is interfered with by the presence of hydrochloric acid or its salts, and also by organic matter.

(*b*) *The Ammonio-Cupric Sulphate Test.*—This reagent is formed by adding ammonia to a solution of copper sulphate till the bluish-white cupric hydrate first produced is almost all redissolved. The clear liquid is filtered off and used. An excess of ammonia will spoil this test, as well as the former one, by dissolving the precipitate.

When this solution is added to a solution of arsenious oxide it produces a light green precipitate of cupric arsenite or Scheele's green, $CuHAsO_3$, soluble in acids and ammonia, but not in potassic or sodic hydrates. The reagent must be used with discretion, or its blue color will hide the reaction. If the arsenic is in small amounts the mixture must be allowed to stand for some time, when the precipitate will settle out.

This test is also interfered with by the presence of organic matter, and is about as delicate as the preceding one, responding to about 1-10,000 of a grain of arsenic.

3. Tests used for Arsenic in Complex Solutions.—(*a*) *Precipitation as Sulphide.*—Sulphureted hydrogen gas, when passed for some hours through a warm solution of arsenious acid, acidified with hydrochloric acid, will precipitate the arsenic as a bright yellow, amorphous precipitate of arsenious sulphide, As_2S_3. This precipitate dissolves readily to colorless solutions in the caustic and carbonated alkalies, and in the sulphides of the alkaline metals. It is insoluble in cold, and dissolves but slightly in boiling, concentrated hydrochloric acid. It is oxidized by hot nitric acid, and dissolves, forming arsenic acid. The test is delicate, reacting (Wormley) with 1–5000 of a grain of As_2O_3, dissolved in ten grains of acidified water.

Similar yellow precipitates are formed by the sulphur itself, and also by the sulphides of cadmium, tin, antimony, and selenium. Hence the precipitate must be filtered off, dissolved on the filter in a few drops of ammonia, and this solution evaporated to dryness, and tested for arsenic by some of the previous tests, or by Reinsch's test, described below.

This test may also be used for quantitative work. The sulphide, formed with great care, and purified as much as possible, is, as before, dissolved from a filter with a little ammonia, into a weighed watch-glass, and on careful evaporation its weight is determined. It cannot be too urgently insisted on that any and all forms of the poison, isolated in this or other tests, should be most carefully preserved, and presented in court for inspection and, if necessary, subsequent testing.

It has been satisfactorily proven that the sulphureted hydrogen, if well washed, cannot introduce arsenic, even when made from impure materials, into the suspected solution.

(*b*) *Reinsch's Test.*—If an arsenical solution, acidified with one sixth or one eighth of its bulk of pure hydrochloric acid, is boiled for half an hour or so with a bright strip of pure copper foil, any arsenic present will be deposited on the latter as a dark metallic coating. The latter can be, and must be, in every case distinguished from similar coatings formed by antimony, mercury, silver, bismuth, and other metals, by forming octahedral crystals of arsenious acid when heated in a small reducing-tube. The sublimate thus formed may also be dissolved out of the tube, and tested as before.

The limit of this test, with ordinary reduction-tubes, is about 1-10,000 of a grain, but Wormley, by very fine tubes and minute strips of foil,

obtained the crystals from 1–50,000 of a grain. The test is interfered with by the presence of nitric acid, potassic chlorate, manganese dioxide, and any other substances which would cause the copper to dissolve.

Reinsch's test has been much abused of late years, but, as claimed by Taylor, Wormley, and other excellent authorities, it has many advantages, being simple, easily made, very delicate, and requiring only two pure chemicals. It must be considered, on the whole, as the best test to be used, during life, for examining suspected food, drugs, vomited matter, urine, or fæces, in the case of suspected poisoning, provided the physician or chemist who makes the test is careful to prove the test by forming and recognizing the octahedral crystals.

(*c*) *Marsh's Test.*—This famous test, proposed by Mr. Marsh in 1836, depends on the fact that when hydrogen is set free in an arsenical solution it liberates the arsenic as a gas, arseniureted hydrogen, which can be separately examined.

In making this test an apparatus like that shown in Fig. 77 is usually employed. In the flask is placed some pure granulated zinc, previously coated with a little platinum by dipping into a solution of platinic chloride, and this is covered with diluted, pure sulphuric acid, through

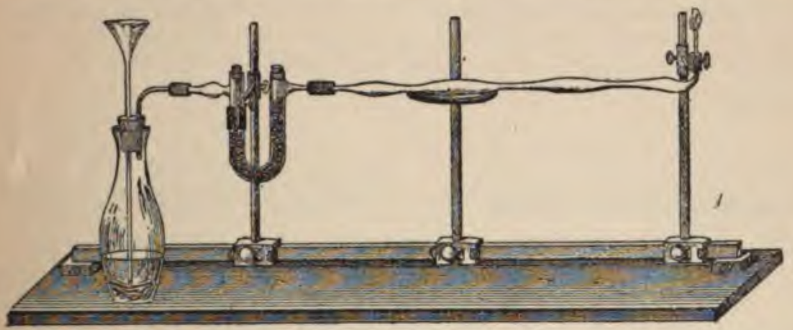


Fig. 77.—Marsh's Apparatus.

the funnel tube. Hydrogen gas is at once formed, and passing through a drying-tube filled with calcium chloride, and then through an ignition-tube with an upturned end, is, after the air has all been expelled, ignited and burns with a pale blue flame.

The utmost precaution must be taken, in this experiment, to have the chemicals perfectly free from arsenic, and under no circumstances should the test be made without running a blank experiment, upon the chemicals alone, using the same time and the same tests as when the suspected solution is being examined.

It has been proposed, by Bloxam and others, to evolve hydrogen by decomposing water in a U-tube with electricity. (*Quart. Jour. Chem. Soc.*, vol. xiii., p. 14; also Doremus and Witthaus, *N. Y. Phys. and Pharm.*, 1879, vol. xii., p. 71.) Unfortunately, a little arsenic is always lost by combining with the platinum electrode.

After the apparatus has been properly tested, and the hydrogen has been ignited, the arsenical solution is admitted through the funnel-tube.

The arseniureted hydrogen is evolved almost immediately, and the color of the ignited gas changes to bluish white, with some white fumes of arsenious oxide.

This gas can be tested for arsenic in three different ways:

1. *By Forming Metallic Mirrors from a Burning Jet.*—If a piece of cold porcelain is placed close down over the flame, any arsenic present will be deposited as a black, or brown, stain or ring. By changing the place directly a good spot is made or the porcelain gets hot, a whole series of stains can be made from minute amounts, 1–5000 of a grain or so of the poison. Wormley states that the amount of arsenic in a good stain may not be over 1–80,000 of a grain.

These stains can be distinguished from exactly similar deposits made by antimony by their solubility in bleaching-powder and hypochlorite solutions and in hot nitric acid; by the argentic nitrate test; and by dissolving, though with difficulty, in yellow ammonium sulphide solution, and leaving, on evaporation, a film of yellow arsenious sulphide, which dissolves easily in ammonia, but is insoluble in hydrochloric acid. The antimony sulphide, formed in this last way, is orange-red, and, while dissolving readily in concentrated hydrochloric acid, is insoluble in ammonia.

2. *By Depositing Metallic Arsenic when Heated.*—In this test, proposed by Berzelius, an ignition-tube of hard glass is used, drawn out, as in Fig. 78, into two, or even three, very narrow constrictions. By strongly heating the tube, protected by and supported on wire gauze, if neces-

Fig. 78.—Ignition-Tube, for Berzelius-Marsh Test. (Dragendorff.)

sary, in front of these places, the metallic arsenic will be deposited on the narrowed parts of the tube. If more than one flame is used almost all, if not all, the metal should be deposited by the first one, and the others are used as a safeguard, and as a proof that no poison is escaping.

The deposit can be distinguished from that produced by antimony by the test above mentioned. It is claimed that a similar deposit can be formed from the presence of much organic matter in the solution. When properly made the test is exceedingly delicate, giving a characteristic deposit (Wormley) with 1–50,000 of a grain dissolved in one hundred grains of liquid.

It can be used as a quantitative test by cutting off the little piece of tubing which contains the mirror, and after weighing it carefully, dissolving out the arsenic and weighing it again. The loss of weight will be due to the metallic arsenic, while the solution of the latter can be subjected to further tests. (For full description see Chittenden and Donaldson, *Am. Chem. Jour.*, vol. ii., p. 235.)

When the quantities of metal thus deposited are too small to be weighed they can be more or less roughly determined by comparison with similar deposits made under similar circumstances, by known

amounts of the poison. (See Fig. 79). The results from this are only partially successful.

3. *By Decomposing Silver Nitrate Solution.*—If the gas, instead of being ignited, is passed, by a bent tube, into a weak solution of argentic nitrate, it will dissolve, forming arsenious acid, H_3AsO_3, and decompos-

Fig. 79.—Arsenic Deposits in the Berzelius-Marsh Test. (Robert.)

ing the silver salt into nitric acid and metallic silver. The latter can be filtered off, and any excess of silver nitrate removed by hydrochloric acid, after which the arsenic in solution can be tested for and isolated as before.

Both sulphureted and phosphoreted hydrogen give similar black deposits, and so, under similar circumstances, does antimony. The latter, however, is itself precipitated as argentic antimonide, Ag_3Sb, and hence, on filtering and washing, can be completely separated from the arsenic, which remains as in the filtrate.

Examination of Drugs, Food, Vomited Material, etc., for Arsenic.—It is always extremely important to see if any arsenic is present in a solid state. Hence the suspected material should be thoroughly stirred and mixed, with the addition of water, if necessary, and then allowed to settle in a conical glass or tall beaker. From this the liquid and the lighter material can be decanted, but any heavy sediment should be carefully examined, under the microscope, if necessary, for undissolved arsenic. If found it should be separated as completely as possible, and with a minimum of agitation and solution, for special testing.

The rest of the material should be filtered, and the solid matter should be boiled thoroughly with hydrochloric acid until thoroughly disintegrated, and then mixed with the filtrate. The mixture is concentrated, if necessary, and its bulk carefully measured, after which portions of it are tested for arsenic by Reinsch's or Marsh's test. If arsenic is present it may be determined quantitatively as described.

Separation of Arsenic from the Tissues.—The above method will do very well for qualitative tests. It is, however, universally agreed, by all the best authorities, that when small amounts of arsenic are to be quantitatively determined in the presence of large quantities of organic

matter, the latter must be completely removed in one way or another, or the results are bound to be untrustworthy. Unfortunately, this is no easy task, for both arsenic itself and especially arsenious chloride are volatile, the latter at quite low temperatures, and unless care is taken the arsenic will disappear with the organic matter.

Dr. Taylor proposed and used a simple method of obtaining the arsenic as chloride, in a comparatively pure condition, by distilling the dried tissues with pure hydrochloric acid, on a sand-bath, and condensing the fumes in a receiver containing water. The chief trouble with this process is the fact that arsenious sulphide is not decomposed by it, and hence there may be a loss of arsenic.

The most approved methods, nowadays, of preparing the tissues for examination depend upon oxidizing the organic matter either with hydrochloric acid and potassic chlorate (Fresenius and Babo) or by the use of sulphuric and nitric acid. In the first, which is most commonly used, the tissues, finely cut, are boiled in hydrochloric acid, with the constant additions of chlorate, until they dissolve to a clear yellow solution. This is strained, washed, concentrated, and treated with sulphureted hydrogen; and the arsenic in the precipitate, after more or less elaborate treatment to remove other metals and organic matter, is determined as sulphide or metallic arsenic.

Full details of this and the nitric acid method have been carefully described by Wormley (*Microchemistry of Poisons*), Doremus and Witthaus (*N. Y. Phys. and Pharm.*, vol. xii., p. 71), Chittenden and Donaldson (*Am. Chem. Jour.*, vol. ii., p. 235), and others.

Distribution of Arsenic in the Body.—In all cases of poisoning it is very important to separate that contained in the contents of the stomach and intestines, whether solid or in solution, from that absorbed in the tissues themselves. The latter represents more or less of the poison which has actually produced death, while the former is simply that left over and which has had no part in killing the individual.

Unfortunately, so much has been said about the characteristic effects of arsenic on the digestive tract that it is common, in cases of suspected arsenic and other poisoning, for the coroner and his staff to submit to the expert for analysis the stomach by itself, or, as a great favor, accompanied with some of the intestines.

Such practice is distinctly bad. It has been recognized for fifty years that most of the absorbed poison will be found in the liver, and after that, in the kidneys, spleen, and heart. These organs will contain the poison after it has almost, if not entirely, disappeared from the contents and even from the tissues of the stomach and the intestines.

Of late years much work has been done upon the absorption of arsenic in the tissues. Some stir was made by M. Scolosoff (*Compt. Rend. Biol.*, 1875, part ii., p. 304), who made various experiments upon dogs, poisoning them with sodium arsenite, and in several cases found three or four times as much arsenic, comparatively, in the brain and spinal cord as in the liver, and some thirty-five or forty times as much as in the muscles.

These experiments raised a storm of contradiction from all over the world, and since then abundant evidence has shown that the liver is, in almost every case, the great seat of the absorbed poison. It is, however, believed by Chittenden and others that in cases of poisoning by a solu-

ble and diffusible salt of arsenic the poison will be found in quantities in the brain. It was, indeed, argued on these lines in the well-known case of Jennie Cramer, where some of the not excessive amount of arsenic present was found in the brain, that the poison must have been administered in such a form. This was of importance in the trial, for it helped the hypothesis of the State that, in spite of the absence of the least sign of gastric inflammation, death was caused by arsenic and not by drowning, the arsenic, taken in a soluble form, acting rapidly, with cerebral or narcotic symptoms.

Many interesting analyses, those of Jennie Cramer's body among the number, have been published of late years, showing the presence of arsenic in the muscles, and in many cases in the bones of the body, as well as in the organs. This was done with the utmost care by Johnson and Chittenden (*Am. Chem. Jour.*, vol. ii., No. 5) in the case of a Mrs. Riddle, where 2.38 grains of white arsenic had been previously found in the internal organs. The defense claimed that this was not necessarily a fatal dose, and accordingly further analyses were made of tissue from the arm, thigh, feet, and hand, of a thigh bone, and of a transverse section of the body itself—in all, over twenty-one pounds of material. From this analysis it was calculated that the whole of the body not previously analyzed contained 2.85 grains, making the respectable total of over five grains.

This precaution, it will be remembered, was not taken in the Maybrick trial, where the stomach, intestines, liver, bile, spleen, and kidneys were the only portions submitted to analysis, and where the only weighable amount of arsenic, excepting a minute quantity in the intestines, was found in the liver, which contained about one third of a grain. Hence the defense was able to claim that death had not been caused by arsenic, because a fatal dose of arsenic was not extracted from the tissues.

This argument is a thoroughly misleading one, and, as will be shown, has absolutely no basis in fact. Arsenic is not a normal constituent of the body, and when once absorbed is rapidly eliminated in many different ways. And more than one case is on record where death has undoubtedly been due to arsenic, and yet not a trace of the poison has remained in the principal organs of the body, if not in the whole body.

In chronic arsenic poisoning, or in cases where death has been delayed for several days, or even weeks, the examination of the body outside the principal organs is still more important. In the Havre cases, already discussed, arsenic was discovered in the skin, nails, and hair of the victims. Careful experiments by Dr. Pouchet (*Ann. d'Hyg.*, 1889, vol. xxii., pp. 356, 486) tend to show that, when administered slowly, arsenic may be detected not only in those parts, but also and more noticeably in the spongy tissue of the bones, especially in the vertebræ, scapula, and bones of the cranium, for weeks after it has disappeared from the liver and viscera, and even from the other tissues of the body.

Amounts of Arsenic Found in the Body.—The quantity of arsenic that may be present in the contents of the stomach and intestines is very large. Dr. Pearson, in the Cross trial in Ireland, in 1887, testified that over two ounces had been so found, and reports of one ounce and over are not uncommon.

The amount, however, actually present at any one time in the tissues

themselves is far smaller, and in perfectly well authenticated cases of arsenic poisoning they have diminished to the vanishing-point.

As just stated, the liver is the main source of the poison, and yet in the liver it is hard to find it in any great quantity. The average amount seems to be from one third to two thirds of a grain. Wormley, an excellent authority, states that "the absolute quantity thus found, even under the most favorable circumstances, rarely exceeds a grain in weight." In some cases, indeed, the presence of larger quantities, as, for instance, in the Cross case, where 1.28 grains were found, has been made a ground for disputing the analysis. In that same trial the learned judge was so impressed with the defense's view of the case that he solemnly charged the jury that the liver was like a sponge, and that from one to two grains of arsenic was its total capacity.

His honor, however, was evidently napping on this occasion, for larger amounts have been not infrequently reported. Hayes, for instance (*Am. Chem.*, Dec., 1875), found 3.86 grains of arsenic in the liver of a lady who died in forty hours after drinking some poisoned tea prepared by a crazy servant. While the largest amount of arsenic yet found was reported by Dr. Barker (*Am. Chem.*, 1872, vol. ii., p. 441), in the Lydia Sherman case, where he isolated from the liver of Horatio Sherman, her fourth and last husband, arsenic equivalent to nearly five grains for the whole liver; and obtained over seven grains from the liver of Dennis Hurlbert, a previous husband. These results seemed so remarkable, and such a slur had been recently cast upon expert testimony by the fiasco in the famous Wharton case, that Professor Barker was particularly careful to isolate the poison, to bring the poison itself into court, and to preserve it, in various forms, for future reference.

As a general rule the amount of arsenic found in any of the other organs—the kidneys, spleen, stomach, intestines, heart, bladder, and brain—is not as much as that found in the liver, nor does the total amount often exceed five grains. To illustrate the amounts that have been found in different portions of the body, we give here two famous analyses, made by Johnson and Chittenden, and by Chittenden alone, published in the *Am. Chem. Jour.* (vol. ii., No. 5, and vol. v., No. 1):

MRS. RIDDLE (A CASE OF CHRONIC ARSENIC POISONING).

Internal Organs.	*Arsenic Found.*
Stomach and spleen	0.825 grain.
Kidneys	0.103 "
Liver	0.738 "
One lung and heart	0.235 "
Intestines and uterus	0.388 "
One lung and liquid from thorax	0.091 "
Urinary bladder, etc	Distinct trace
Brain	Unweighable trace
Total	2.380 grains.

Other Tissues.	*Total Weight.*	*Total Arsenic.*
Arm	2 lb. 6¼ oz.	0.111 gr.
Leg	12 " 4¾ "	0.408 "
Muscular and bony tissue, including transverse section of body	6 " 7¾ "	0.577 "
Total	21 lb. 3 oz.	1.096 grs.

The body, exclusive of the internal organs, weighed 880 ounces; hence it was calculated that the whole amount of arsenious acid to be found in it was 2.846 grains, which, added to the 2.380 grains found in the internal organs, amounted to 5.226 grains for the whole body.

JENNIE CRAMER (CLAIMED TO BE A CASE OF NARCOTIC POISONING FROM A SMALL DOSE OF DISSOLVED ARSENIC).

Internal Organs.	*Amount of As_2O_3 Found.*	
Stomach and œsophagus	0.158 grain.	
Liver ($\frac{1}{2}$)	0.109 "	
Intestines	0.314 "	
Kidneys	0.029 "	
Heart ($\frac{1}{4}$)	0.028 "	
Lungs and spleen ($\frac{2}{3}$)	0.1146 "	
Brain ($\frac{1}{3}$)	0.0255 "	
Trachea, larynx, and tongue	0.081 "	
Diaphragm	0.010 "	
Total arsenic found		0.8691 grain.
Liver ($\frac{1}{2}$)	0.109 grain.	
Heart ($\frac{3}{4}$)	0.084 "	
Lungs and spleen ($\frac{1}{3}$)	0.0573 "	
Brain ($\frac{2}{3}$)	0.050 "	
Rest of arsenic calculated		0.3003 grain.
Total arsenic in internal organs		1.1694 grains.

Muscular and Bony Tissue.	*Total Weight.*	*Arsenic.*
Left arm	2 lb. $11\frac{1}{4}$ oz.	0.094 grain.
Right leg, except thigh-bone	10 " 4 "	0.118 "
Thigh-bone	$7\frac{1}{2}$ "	
Transverse section of body	8 " $15\frac{1}{2}$ "	0.186 "
Muscle from heart	1 " $2\frac{1}{4}$ "	0.098 "
Muscle from back	1 " 6 "	0.356 "
Total	24 lb. $14\frac{1}{2}$ oz.	0.852 grain.

The entire body, exclusive of the internal organs, weighed fifty-seven pounds. Hence, on calculation, the amount of arsenic in the body was 1.9498 grains, which, added to that found in the internal organs, gave a total of 3.1192 grains.

The body of Mrs. Riddle had been buried for a year and a half, while that of Jennie Cramer was analyzed but a few days after death.

Amount of Arsenic Necessary to Prove Poisoning.—As before mentioned, it is very common for the defense to insist that, in a case of supposed arsenic poisoning, unless full fatal doses of arsenic are found absorbed in the system, the prosecution has failed to prove the cause of death. To be sure, in view of the almost universal presence of traces of arsenic and the extraordinary delicacy of the tests, it is generally considered improper to convict of poisoning on the evidence of mere traces, unless overwhelmingly corroborated by other evidence.

Orfila himself at one time asserted the presence of minute quantities of arsenic in the normal human body; and yet, but a few years afterward, in the dramatic case of Madame Lafarge, after two separate sets of chemists had failed to find any arsenic in the body of her husband,

Orfila obtained her conviction by finding, with Marsh's test, mere unweighable stains, amounting all told, as he estimated, to not over 1-100 of a grain. This amount is to be considered below the limit, especially when, as came out in a subsequent trial, the zinc used by Orfila in his Marsh's apparatus on that occasion had not itself been tested for arsenic. Another case, where very small amounts of arsenic formed the most conclusive evidence against the prisoner, was that of Margaret Wishart, convicted on an analysis, by Sir R. Christison, showing one fortieth of a grain in the linings of the stomach.

When, however, the arsenic extracted is in weighable quantities, and in such a form that it can be isolated and shown to the jury, and when the care shown by the analyst and his previous reputation make it reasonably certain that the arsenic in question came from the cadaver, it is perfectly proper to insist that quite minute quantities of the poison furnish very strong evidence of the cause of death.

Indeed, the best experts are agreed that in perfectly well-defined cases of arsenic poisoning it is not only not uncommon to find but small amounts of the poison, but it may easily happen that no arsenic at all may remain in the system. The case of Dr. Alexander, previously mentioned, is one often quoted. He lived sixteen days after a fatal dose of white arsenic. There was no question whatsoever as to the cause of death, and yet Dr. Geoghegan, professor of medical jurisprudence in the Royal Medical College in Dublin, and an expert of great experience and ability, found no trace of arsenic in the contents of the stomach nor in the viscera.

Elimination of Arsenic.—When arsenic is taken into the system through the stomach, but a short time elapses before nature endeavors, by constant and thorough vomiting, and subsequently by purging, to expel the poison before too much has entered the circulation. That this is frequently successful is well known from the numerous instances of persons who have taken large doses and recovered without special treatment. The poison that is absorbed enters the portal circulation, and is stopped by the liver, which retains as much of the arsenic as possible.

The poison begins to be stored up in the liver probably in a few minutes, if not seconds, after it is absorbed, and gradually increases in quantity for some fifteen or twenty hours. But from the time it enters the system until it is entirely removed or death intervenes, active agencies are at work to eliminate it from the body.

The most important of these is the kidneys, which begin their work almost at once. Dr. McLagan, when experimenting on arsenic eating in Styria, found arsenic in the urine three quarters of an hour after taking the drug; while in a case fully reported by Prof. E. S. Wood (*Boston Med. and Surg. Jour.*, 1888, vol. xix., p. 435), it was present in the urine within five minutes after it had been taken.

Besides this, the arsenic is excreted through the bile, the skin, and probably, after some little time, at least, through the large intestine. So it is perfectly evident that if the patient does not die for some time the amount of arsenic present in the system must be diminishing every day and every hour, and sooner or later will disappear entirely.

Opinions differ as to the length of time required for such disappearance. All the older authorities, Orfila, Christison, Herapath, Geoghegan, Taylor, and others, agree that from fifteen to twenty days would suffice

to remove all traces from the body. These writers, however, rarely examined more than the main viscera, and it is probable that a careful examination of the muscles, and especially of the bones, skin, nails, and hair of the victim might have shown at least traces of the poison for much longer periods. In experiments on animals Ludwig found arsenic, in some quantities, in the liver of a dog after forty days, and it is probable that traces of arsenic would still be found in the body, if carefully looked for, for two or three months at least after the poison had been taken.

Indeed, if we are to believe the wonderful stories published by some of the Massachusetts doctors, exposure to infinitesimal traces of arsenic is liable to leave evidences of that poison in the urine not only for months, but for years, after removal from the contagion. (See Putnam, *Boston Med. and Surg. Jour.*, vol. cxix., p. 3, and others.)

Detection of Arsenic after Long Periods.—It has been often noticed, when bodies containing arsenic have been exhumed after some months or years, that the tissues are unusually well preserved, seemingly in proportion to the amount of poison which they contained, and also that the stomach and intestines are often lined with a bright yellow deposit. An excellent example of this is shown in the frontispiece illustration (Plate I.) of this volume.

This deposit has been usually considered to be the yellow arsenious sulphide, formed by sulphureted hydrogen coming from the decomposition of the tissues. In some cases, at any rate, this compound contains no arsenic at all, but consists of organic compounds probably derived from bile. The subject is thoroughly discussed by Drs. Brown and Davies (*Lancet*, 1884, part i., p. 421) in the case of persons poisoned at Liverpool by fly-paper solution; and also by Stevenson (*Brit. Med. Jour.*, 1884, part i., p. 600), who insists that the yellow deposit is sometimes, without question, arsenious sulphide, and proves it from his own experience.

Whether it is due to the formation of this sulphide or of some other stable compound, it is quite certain that after a body has once been buried no great loss of arsenic occurs either by volatilizing or leaching. Accordingly mere lapse of time is no bar to the detection and isolation of arsenic. Cases are on record, both in this country and Europe, where crimes have thus been traced, and the murderers convicted, after ten, fifteen, and even twenty years.

Under these circumstances, every precaution must be taken to satisfy the jury that the poison could not have come from the earth, coffin, or coffin-lining, clothes, ornaments, or other post-mortem sources. This, in former years, presented no such great difficulty, but at present, in this country, the universal habit of embalming renders it almost impossible, unless strong suspicions have been aroused before death, to convict of poisoning not years and months, but days and even hours, after a person has died.

Post-mortem Imbibition of Arsenic.—The possibility of the intentional injection of arsenic after death, so as to throw suspicion on suspected persons, was suggested by Orfila in 1813, and has been referred to since by most of the authorities. Only two cases, however, so far as I can learn, have yet reached medical literature.

In the case of Mrs. Bleazby (Kidd, *Dublin Quar. Jour.*, 1850, vol. x., p. 73), the defense claimed, from post-mortem appearances and other

reasons, that the arsenic found in stomach, kidneys, and liver had been introduced into the stomach after death. In this case the chemist for the crown swore that under such circumstances it could not possibly have reached the liver or kidneys, for "absorption ceases directly after death." A second case (Reese, *Trans. Coll. Physicians*, Phila., 1877, vol. iii., p. 23) is of an old man who married his housekeeper, and before death left her all his property. There was constant squabbling over the will, and finally, three or four years afterward, the widow, who had married again, was accused of poisoning her first husband. The body was exhumed and arsenic found in the stomach and intestines, though not in the form of sulphides; but the case was dropped, owing to the strong suspicions that some of the relatives had tampered with the body.

Since, however, arsenical solutions have been used for embalming purposes, there is no doubt at all but that more than once they have been used to conceal crime. This possibility was first pointed out in an excellent letter of Dr. Hay to the *Medical Times* (1876, vol. vi., p. 576), after, at the request of an undertaker, he had analyzed a much used and highly recommended embalming fluid, and found it a strong solution of sodium arsenate.

This possibility was soon proved to be a fact, for not long afterward Vaughan (*Jour. Amer. Med. Ass'n*, 1883, vol. l., p. 115) published a case where a husband injected, with the aid of his brother and an undertaker, some arsenic into the mouth and rectum of his dead wife, to "preserve her body till he could get a handsome casket from a neighboring city." The body after one hundred and five days was exhumed, and arsenic was found in the stomach and liver, although not in the brain or calves of the legs. But it was impossible to tell whether it had come from the injection or not.

A more striking case was reported (*Boston Med. and Surg. Jour.*, 1890, vol. cxxii., p. 544) by one of the Massachusetts medical examiners, who was evidently much chagrined by the facts he mentioned. A young married woman died very suddenly, two hours after luncheon, with symptoms of violent irritant poison. The medical examiner was sent for, and although he was out of town at the time, he reached the house at about eight o'clock that night, within seven hours after the woman had died. But already an undertaker had been called in, and the body had been embalmed with an arsenical solution, and so, although there was every ground for suspicion and the body was full of arsenic, the case had to be dropped.

The most remarkable case of all, however, which has once or twice been referred to, although not in detail, in some of the journals, was laid before some prominent legal, chemical, and medical experts, of whom Professor Chandler was one, some nine years ago. As I write, all the documents of the case are before me.

From these it appears that the wife of a country clergyman, after a year or two of married life, died, in a country village in this State, under somewhat suspicious circumstances. Some of the relatives started an investigation. The husband, an attractive, intelligent-looking old gentleman over sixty years old, had come to New York soon after the funeral and was, at the time, preaching regularly every Sunday afternoon in one of the most prominent Fifth Avenue churches.

It was soon found that he had had at least six wives. Detectives, ac-

cordingly, started to study up the deaths of wives numbers five and four, as well as of the last one, while two other detectives, one of them living at the same boarding-house as the reverend gentleman, made daily reports as to his life and occupation. He appeared, indeed, to have somewhat recovered from the recent bereavement, for, besides his clerical work, the reports showed that he was devoting himself assiduously to one of the fair residents at the boarding-house. But suddenly, probably because he heard of the investigations going on in the country, he packed up and started for Europe. He was heard of the next year, with wife number seven, in charge of a parish in New Mexico.

The investigations, which are most interesting reading, show that he generally selected for his better halves old maids, with some property of their own, living in country villages. Soon after marriage he would move to another country parish, and, almost as soon as he had settled there, he would spread reports of his wife's ill-health and poor constitution. The wife would soon be taken sick, and, treated by the local country doctor, would alternately get better and worse, until she died. Before death she would have made a will leaving her devoted husband all her property, and immediately after a hasty and superficial autopsy, at which he himself was generally present, the body would be thoroughly embalmed with arsenic. His grief would be so great that he would be obliged to give up his parish and leave for other parts, where he would console himself anew.

As can easily be seen, there was no possibility of proving anything in such a case, although suspicious circumstances without number were brought to light. The experts unanimously advised the abandonment of the case, and the worthy clergyman, if his former good health has not deserted him, by this time has probably reached wife number eight or even number nine.

Possibility of Distinguishing Anti-mortem from Post-mortem Arsenic.—This question has been discussed by most of the writers on poisons, and numerous experiments have been made on it in connection with the different cases already mentioned. Orfila, Dr. Kidd, and Professors Reese and Vaughan (*loc. cit.*) all have published experiments on the subject, and, as a rule, agreed that while, with sufficient length of time, arsenical and other metallic solutions would travel far and wide through the body, it was very improbable, to say the least, that within any moderate length of time such compounds could enter the brain.

The whole question, however, was finally settled, once for all, by some experiments made by Professor Witthaus, and described in an excellent paper in the first volume of the *Researches of the Loomis Laboratory*, 1890. Professor Witthaus was engaged by the State to examine the body of a certain Mrs. Ford, supposed to have been poisoned by arsenic. The corpse, which had been dead fourteen days, had been embalmed by injecting into the stomach through the nostril a solution of sodium arsenate, some four pounds to the gallon. The undertaker stated, by the way, that, excepting in very cold weather, it was his invariable habit to do this embalming as soon as possible after death. Upon analysis arsenic was readily found, not only in the viscera, but also in the brain. But on making exactly parallel experiments upon cadavers by injecting similar solutions and similar amounts in the same manner, or even more carefully, it was found that within fourteen days

arsenic had penetrated from the stomach into every part of the body, including the muscles of the feet and legs, the hands, the arms, and, finally, every portion of the brain. The case accordingly was dropped.

At the present moment it would seem that, if once the undertaker is allowed to enter the house, there is no chance of conviction, in arsenic poisoning. This means that arsenic, instead of being the most dangerous, is now, practically, the safest agent for committing murder. And also, that unless the attending physician is clever enough to properly diagnose the case during life, and is courageous enough to risk his own professional career by calling in the authorities and insisting on an autopsy at once, there is practically no hope of conviction.

(c) *Arsenic Acid and Arsenates—H_3AsO_4.*

Arsenic acid is formed by the oxidation of arsenious oxide with nitric acid or aqua regia. The arsenic oxide thus formed has a formula of As_2O_5, but it absorbs water very readily, even from the air, thus forming the true acid, H_3AsO_4.

The latter is a thick, syrupy, colorless liquid, with a sour, metallic taste. It is quite caustic, and has poisonous properties similar in every respect to those of arsenious oxide. It has been largely manufactured for use as an oxidizing agent, but has been superseded of late, in the aniline and kindred industries, by other and non-poisonous compounds.

The tests for this substance are like those for arsenious oxide. It reacts promptly with Marsh's test, the nascent hydrogen reducing it rapidly to the lower oxide, and then to arseniureted hydrogen. It responds to Reinsch's test, but not as well as white arsenic. Sulphureted hydrogen, however, precipitates it very slowly, if at all, from dilute solutions, unless it has been first reduced to arsenious oxide.

Characteristic tests for it are with argentic nitrate, which gives a brick-red precipitate, and with ammonio-magnesic sulphate (formed by adding ammonic hydrate to magnesic sulphate till the white precipitate is redissolved), which gives a white, crystalline deposit of ammonio-magnesic arsenate. Cases of poisoning are extremely rare, and when they do happen present about the same characteristics as those from white arsenic.

One case of a child who ate some "pest poison," consisting of arsenate of soda, was published by Prof. B. Silliman, in an interesting paper read before the New York Medico-Legal Society, October 3, 1883. The child died in about nine hours, without symptoms of any gastric or intestinal irritation, but with such strong evidences of narcotic poisoning that the poison was first thought to be an alkaloid of the belladonna type.

(d) *Arseniureted Hydrogen—Arsine—AsH_3.*

This gas, as already mentioned, is produced by the action of nascent hydrogen upon solutions of arsenic. It is formed in laboratories in making Marsh's test, and also occasionally is produced in the arts when metals contaminated with arsenic are treated with acid.

It is a colorless, inflammable gas, with a garlic odor. It burns to water and arsenious oxide, deposits metallic arsenic when heated, and

precipitates metallic silver when passed into argentic nitrate, the arsenic dissolving in the nitric acid set free.

It has marked poisonous qualities, not only producing the usual effects of arsenic, but also having a specific action on the blood and kidneys. The blood becomes dark and inky, while the kidneys become much congested, and the flow of urine, which is dark and full of blood, is much diminished and even stopped. The victims also suffer usually from jaundice.

The gas, however, is not nearly as poisonous as is supposed, for it is evolved in considerable quantities by the students in almost every qualitative laboratory in the world, and yet it is extremely rare to hear of any accidents from it. Its discoverer, Gehlen, was poisoned by it from trying to trace a leak in his apparatus by smelling at the joints, and three or four similar instances are reported in the books and journals, but that is all.

Cases have occasionally been reported where accidents have happened from it in the arts. In one case (Coester, *Deutsch. Med. Wochensch.*, 1884, p. 119), a workman in an aniline factory inhaled some hydrogen containing some of this gas. He suffered at first from nausea, giddiness, and general discomfort. Then he had jaundice, and passed practically no urine after the first day, when it was bloody, dying, in spite of treatment, on the tenth day.

Similar symptoms were reported in a very interesting case (Dr. Frost, *Vierteljahrsh. für Gerichtl. Med.*, 1873, vol. xviii., part ii., p. 6), fully quoted by Sonnenschein, Blyth, and others, where twelve workmen, three of whom died, were seriously affected by fumes from treating zinc with hydrochloric acid. The early symptoms were followed by jaundice, bloody urine, and narcotic sleep, while in the fatal cases the urine was suppressed, and death occurred in a state of coma.

In all these cases arsenic was found in all parts of the body.

(*e*) *Sulphides of Arsenic—Realgar, As_2S_2, Orpiment, As_2S_3.*

These two compounds, the red sulphide containing seventy percent. of the metal, and the already mentioned yellow or arsenious sulphide, containing sixty-one percent., occur in small quantities in nature, and are manufactured for use in the arts.

Their toxic effects, tests, etc., are practically the same as those of white arsenic.

(*f*) *Soluble Salts of Arsenic.*

These usually consist of the arsenites and the arsenates of the alkaline metals. An example of these is the officinal Fowler's solution, which contains arsenic to the amount of one percent., dissolved in a solution of potassic carbonate.

The poisonous effects of these salts are much the same as those of white arsenic, excepting that, being soluble and easily diffused, they usually act more rapidly, penetrate the brain and nerve tissue sooner and in greater abundance, and produce symptoms rather of the narcotic or cerebral type.

(g) *Paris Green—Schweinfurth Green.*

This compound, an aceto-arsenite of copper, containing some 58.4 percent. of arsenious oxide, has of late years come into common use as a poison for potato-bugs and similar insects, and, especially in country districts, has been frequently used as a means of suicide. Accidents from its use are occasionally met with, but are rare.

Internally its symptoms are the same as those produced by white arsenic, excepting that it is still more difficult to wash it out of the stomach. Externally it occasionally produces rashes and similar surface disturbances upon workmen engaged in its manufacture, and upon farm hands who use it carelessly, especially if their fingers or arms are at all sore. But it is rare that these results have any serious consequences.

(h) *Arsenic in Wall-paper and Other Fabrics.*

For a great many years there has been a feeling, expressed not only by the laity but also by many physicians and toxicologists of excellent standing, that there was more or less real danger in the free use of arsenical pigments, like Paris or Scheele's greens, for instance, in the manufacture of wall-paper, and also of various articles of household use —dresses, carpets, book covers, water-color paints, toys, and the like.

With regard to some of the latter the feeling was undoubtedly correct. To color children's toys, or pigments, or confectionery, or, in many cases, book covers, with Paris green, is simply to invite accidents. With regard to dress materials, carpets, and the like, there is more cause for doubt, although a light tarletan, full of Paris green which can be shaken off as a fine dust by the mere exercise of dancing, may be not unjustly considered as needlessly dangerous.

For some reason, however, the cry was concentrated against wall-papers, which, even when made fluffy and velvety, as was the custom, and full of loosely adhering arsenical pigment, are, owing to their stationary position, far less liable to give rise to accidents than the articles just mentioned. Indeed, it is more than doubtful whether a single case of fatal, or even dangerous, arsenical poisoning has *ever* been caused by wall-paper, although minor accidents may occasionally have occurred. For instance (*Lancet*, 1879, part i., p. 686), two children are reported to have been seized one morning with vomiting, cramps, and diarrhœa, after amusing themselves with repainting the walls of their room. They used their fingers as paint-brushes, and would lick them to get them wet, and then rub off green paint from one part of the wall to put it on another.

At any rate, in obedience to the wishes of the consumers, manufacturers have practically ceased to use arsenical pigments in any quantity, not only on toys and the like, but also on wall-papers. The latter are, as a rule, thin and lightly painted, and the pigment is firmly fastened on with size and generally glaze, and now, instead of finding from fifty to several hundred grains of arsenic to the square yard, it is quite rare to find a paper with more than one or two. The presence of the latter, too, is almost always accidental, and results from the impossibility of getting paper, sizing, paints, and so on, absolutely pure from arsenic.

Nevertheless the same old cry against arsenical wall-paper, which now has absolutely no basis, still goes on, and has risen in the fine old State of Massachusetts, during the last ten years, to an actual craze, an "arsenic fad," as some outsiders have dared to call it.

The excitement culminated in two different attempts to pass legislation forbidding, under heavy penalties, the presence in wall-paper, and, to a less extent, in other fabrics, of more than a minute fraction of a grain to the square yard. The evidence, which is given in great detail by Professor Wood (*Report Mass. State Board of Health*, 1885) and by Professor Lyon, Professor Hill, and many of their friends and colleagues, in the Arsenical Wall-paper Hearing, House Bill No. 417, 1886, and in the Hearing before the Committee of Public Health, Senate Bill No. 215, 1891, is exceedingly interesting and entertaining, and deserves a brief review.

The susceptibility of the victims was extraordinary. Professor Lyon (*Senate Hearing*, p. 121) stated that a member of his family was seriously affected (sleeplessness, repeated colds, tenderness in throat, skin and nervous symptoms) by the mere presence in the room of a lounge containing, all told, in its coverings and linings, about 1.8 grains of arsenic. Professor Wood, too, gives a case (No. 31) of obstinate eczema of the hands, from using playing-cards containing on their backs one eighth of a grain of arsenic apiece. And in another case (*Senate*, p. 14), fever was caused by the mere presence in the room of a red-and-yellow comforter, which, on analysis, showed a little arsenic.

The climax, perhaps, was reached in the much-quoted case of a child (*Senate*, p. 19) whose father, a physician, stated that severe symptoms of Bright's disease had been produced (*a*) from a plush seat in an arm-chair; (*b*) from a slightly arsenical border in a room; (*c*) from some arsenical paints frescoed on a ceiling; and finally, by the presence of some green glazed paper boxes in a closet of a neighboring room. In this, as in the previous cases, arsenic was found in the urine.

The symptoms, too, are interesting, for they include those of practically every slight affection and almost any grave disease that flesh is heir to, and vary from a cold in the head to almost complete paralysis; the latter, by the way (Professor Wood, case 19), occurring within two hours after exposure to the poison. In one famous case, that of ex-Mayor Cobb, of Boston, the long, tedious illness and final death were confidently ascribed to arsenical wall-paper. On autopsy it appeared that the victim had been suffering all along from a cancer of the stomach.

Nor did "age stale or custom wither their infinite variety," for papers which had been on walls twenty-five years and more, and were in good condition at the end of that time, were still quoted as the cause of disease.

The most extraordinary claim of all, however, was that paper, covered over by a non-arsenical one, could still produce disease. Thus (*Senate*, p. 108), irritation of the air-passages, tonsillitis, and other diseases were caused by an arsenical paper completely covered by one free from any trace of the poison. A still more striking case is told yearly to his students by a well-known professor of chemistry, as an illustration of this subtle and deadly wall-paper poisoning. Some persons were taken sick, and the wall-paper was examined, but found free from arsenic. This was scraped off and the underneath one examined, but also found non-arsenical. Not content with this, a third paper was uncovered, and, to

the good professor's huge delight, traces of arsenic were found in some flowers with which it was decorated. This paper, number three, is now triumphantly exhibited to his classes as an example of a physician's ability and a chemist's perseverance!

It will be seen at once that these results could not have been supposed, by the greatest enthusiast, to have been the work of ordinary Paris green, mechanically dislodged from the walls. So a theory was propounded, based on papers by Fleck (*Zeitsch. f. Biol.*, vol. viii., p. 444) and Hamburg (*Pharm. Jour. and Trans.*, August 1, 1874), that, by the action of microbes, arseniureted hydrogen was constantly being evolved from arsenical pigments and dye-stuffs.

Sad to say, Prof. C. F. Chandler, called on from New York to testify on the subject, demolished this whole story in very short order. He explained how, when president of the New York Board of Health, he had, years before, thoroughly investigated the whole subject and found there was nothing to it. Deaths and illness from wall-paper poisoning did not exist in either New York or Philadelphia, and the best physicians and health authorities in both cities agreed in calling it a humbug. He then, after pointing out the general absurdity of the claims, attacked their evidence on two lines: first, that their tests for arsenic were untrustworthy; and second, that arseniureted hydrogen or other poisonous gases were *not* set free from arsenical pigments, as stated.

It so happened that the Boston chemists had determined the presence of arsenic by the simple formation of a dark or black deposit with the Berzelius-Marsh test, and when occasionally they took the trouble to further test this deposit to see if it was arsenic or not, they simply broke the tube and smelled of it, to see if it had a garlic odor. This careless method of testing made all their results entirely unreliable.

About the exhalation theory Professor Chandler not only quoted Hoffman, Henry Watts, Professor Galloway, and others in favor of his views, but described some experiments of his own, never before published, which were made in 1880 while studying the matter for the Board of Health. The claim had been made that in the decomposition of the starch paste enough hydrogen was produced to form arseniureted hydrogen. Two of his assistants, under his direction, mixed Paris green with fresh paste, and with paste in an active state of decomposition, and they also spread Paris green and paste thickly on a sheet of paper. But although they passed air for hours and hours over these surfaces and mixtures, not a trace of arsenic could be found to have volatilized. It is interesting to know that this testimony of Professor Chandler, seconded once by that of Professor Henry Morton of Stevens Institute, Hoboken, was enough to nip the proposed legislation in the bud on both occasions.

This subject has been discussed somewhat at length, partly because the discussions, in which both sides of the question were very fully covered, are not readily accessible to the public; but also because some of the results published of late years in the Massachusetts journals about the presence of arsenic in urine from cases of wall-paper poisoning, will undoubtedly be quoted to the discomfiture of experts unless they can also have access to some of the reasons why those results are to be considered unreliable.

VII. LEAD, PB.

Metallic lead has been known and used by man from the early historical ages, and to this day we can see, notably in England, not only the traces of the ancient mines, but also the old pigs and weights of lead, stamped with the mark of the old smelting-works, and the remains of the original lead pipes used by the Romans to conduct water to their baths.

It occurs in nature principally as the sulphide, galena, and can be readily extracted by smelting with coal and, sometimes, iron.

Properties.—It is a soft, lustrous, heavy metal, with a bluish-white color, melting at about 315° C. It dissolves readily in dilute nitric acid, and with difficulty in hot concentrated sulphuric acid. It is, however, insoluble in cold sulphuric acid, and practically so in hydrochloric acid. In pure water it is not dissolved; but if the water is or has been exposed to the air the lead oxidizes, and then becomes converted into a hydrated carbonate, a white compound, a little of which dissolves in the water, while the rest forms scales and incrustations, which settle to the bottom, or may, in fine particles, be carried along with the liquid. This action of water is supposed to be assisted by the presence of nitrates and also, to some extent, of chlorides, while even small quantities of sulphates and phosphates, or of carbonates, protect lead from corrosion by forming insoluble coatings upon its surface.

As a Poison.—Metallic lead dissolves but slowly in the fluids of the body, and hence has been known to remain in the body for years, as, for instance, in the case of bullet wounds, without causing serious inconvenience. If, however, it enters the circulation, as has been known to happen in those very cases after doses of potassium iodide, it will, even in small quantities, give rise to characteristic symptoms of poisoning.

Cases of acute lead poisoning may occur from taking considerable quantities of the soluble salts, plumbic acetate, or, more rarely, plumbic nitrate. These cases, however, are very rare, and form but a minute fraction of the whole. By far the greater bulk of the victims of lead poisoning have absorbed the metal, purely by accident, in minute quantities, day by day, for considerable periods. The number of these cases is extraordinary; for, as will be seen on reference to the tables on pages 351 and 352, deaths from lead poisoning rank, at least in this country and England, next to those from opium and its compounds, forming some twenty percent. of the whole number; while these figures represent but a small part of the cases more or less permanently injured by its action.

How Introduced into the System.—Chronic lead poisoning is most common among those constantly at work with the metal or its compounds, as, for instance, plumbers, painters, type founders and setters, shot-makers, and the like. In lead works and paint factories it is so frequent that special precautions have to be taken to protect the workmen: the ventilation is looked after, white lead and other powders are ground in water, while stringent rules have to be made and enforced, insisting on great personal cleanliness, and the eating of all food outside the gates of the factory. In many cases, as I have myself seen, sulphuric acid lemonade is furnished freely as a prophylactic drink, and employees who complain of any trouble from constipation are given doses of Glauber's or Epsom salts.

Food.—Innumerable cases of lead poisoning have also been caused by the presence of the metal in ordinary foods, drugs, and drinks. Many people have been poisoned by the presence of lead compounds in flour and bread, in one case (Stourbridge) from accidentally mixing lead acetate with the flour, but in most of the other cases by the careless use of white lead in repairing the grindstones. Foods cooked in lead-glazed pots, beer and cider drawn through lead pipes, wine sweetened with litharge or lead acetate, or kept in bottles carelessly cleaned with shot, sweetmeats and the like packed in tin-foil, fruits and vegetables canned with the use of lead solder, have all contributed their share of victims.

Hair-dyes.—Another very important source of poisoning is the use of cosmetics, hair-restorers, and hair-dyes made of lead salts. The latter aim to reproduce the original brown or black color of the hair by impregnating it with lead sulphide, and hence usually consist of two solutions, one of lead acetate, to be well rubbed into the hair, and the other of alkaline sulphide, to be applied later. In a report on dangerous cosmetics made to the New York Board of Health in 1870, Professor Chandler gave analyses of most of the face and hair preparations sold at the time in the city, and showed that they almost invariably contained large amounts of lead; while a similar state of affairs was shown a few years later by Dr. Benjamin (*New Remedies*, November, 1878).

Water.—The most common source of lead poisoning, to the community at large, lies in the use of drinking-water conveyed through lead pipes or kept in lead-lined tanks. The amount of lead necessary to make a water poisonous need not be large. Thus in the well-known case of the Orleans family, who, after their expulsion from France in 1848, settled at Claremont in England, the use for five or six months of water containing about eight tenths of a grain of lead to the (United States) gallon, produced distinct symptoms of chronic poisoning. As already noticed, the purer the water, and the more free it is from sulphates, phosphates, and carbonates, the more liable it is to attack the lead.

These evil effects were well known to Vitruvius (B.C. 50), Galen (A.D. 130), and other of the earliest authorities, and the use of lead pipe for conducting drinking-water was forbidden, in early days, under severe penalties. But it is so cheap and so convenient for this purpose that its use has never been superseded. Lead tanks are always dangerous, and should invariably be replaced by copper, zinc, or, better, block-tin. If lead pipes are used the precaution should always be taken of letting the water run freely before drawing any to drink. Many cases are on record, in this city as well as elsewhere, of lead poisoning from using drinking-water that has stood overnight in the pipes.

Effects of Lead on the System—(a) Acute Poisoning.—This occurs but rarely, and then usually from taking plumbic acetate, sugar of lead, in considerable quantities. This compound is a white crystalline substance, with a sweet metallic taste, and readily soluble in water. Unlike most poisons, it is less dangerous in one large dose than when the same quantity is taken divided into many smaller doses. Nor can it be considered as a very active poison, for it is given medicinally as an astringent, and to stop bleeding from the bowels, in doses of from two to five grains, and in quantities running up to fifteen and twenty, or even thirty and forty grains a day, without injury. Indeed, the fatal dose of it is

not known, for recovery has taken place in very few days, and with simple treatment, after taking in solution an ounce and more of the compound.

Symptoms.—In the few fatal cases of plumbic acetate poisoning that have been reported, the patient, as a rule, notices at once a metallic taste, and burning and sense of dryness in the throat and mouth. This is followed by vomiting and retching, with pain in the stomach and abdomen, sometimes relieved by pressure. Sometimes there is severe purging, with passage of blood, but usually there is obstinate constipation, and any material passed is dry and colored black, probably from the presence of lead sulphide. The urine is diminished, the breath is foul, and the tongue coated. There is a quick, weak pulse and great prostration.

Time of Death.—If the dose proves fatal the patients usually die in three or four days from prostration. After the first few days they are apt to suffer from the various nervous symptoms of chronic lead poisoning, and after surviving the acute attack they may remain in wretched health for a long time.

Treatment.—The proper antidotes to lead salts of all kinds are the two saline emetics, Glauber's salts and Epsom salts, the sulphates of sodium and of magnesium. These not only counteract the constipating effects of lead and help to remove it from the body, but also convert any of its salts as yet unabsorbed into the insoluble plumbic sulphate. The stomach should be well washed out, and the vomiting and prostration controlled as far as possible by opium, and by stimulants.

After lead has once been absorbed into the system, as, for instance, in chronic cases, it is possible to remove it by doses of potassium iodide. These, however, should be administered with care, or else, by suddenly throwing large amounts of lead into the circulation, the chronic symptoms may be changed into acute.

Post-mortem Appearances.—It is usual to find after death evidences of more or less severe inflammation of the stomach or intestines. The liver and kidneys are also affected if death has been delayed for some days.

(**b**) **Chronic Lead Poisoning.**—This is far more common than any other kind, and indeed presents such a variety of symptoms that probably many cases of it are entirely overlooked. There is much difference among individuals with regard to their susceptibility to small doses of lead. As a rule it attacks the weaker ones first, and especially if they are predisposed to gout. On the other hand, as, for instance, in the case of the Orleans family mentioned above, young children are sometimes not affected.

The poison is usually absorbed through the stomach, but it can penetrate through the skin or the lungs without much difficulty, under the proper exposure. The length of time necessary to produce the poisoning varies, of course, with the amount of lead that reaches the system. Thus the characteristic symptoms may appear in a few weeks or even days, or they may not be noticed until exposure has lasted for years. Indeed, lead is considered to be a poison which slowly accumulates in the body until the poisonous limit is reached, or until the body, becoming weakened from one cause or another, gives way to influences which it formerly resisted with success.

Occasionally there seems to be some local action of the lead. Thus plumbers and painters are usually first paralyzed in the hands, right or left as the case may be, with which they work the most. This, however, precedes the lesion on the other side by only a few days at the most, and it is generally believed that the poison is first absorbed into the general circulation, and then selects the particular organs or parts for attack.

Symptoms.—(*a*) *General Nutrition.*—As a rule, before developing any characteristic lesions the patient feels generally run down and wretched. His appetite fails, his digestion and nutrition are poor, and he feels feeble, and becomes more or less emaciated. This is generally accompanied with anæmia, more or less severe, in which, it is claimed, the red blood-cells diminish in quantity and increase in size at the same time.

The liver is often affected, and the kidney is very commonly diseased, undergoing a parenchymatous inflammation, and finally becoming hard and granular, with diminished excretion of urea. Indeed, many of the later nervous symptoms have been referred, by many good authorities, largely to uræmia caused by the kidney lesions. Abortions are extremely common in the case of pregnant women, and the children of chronic lead patients, as a rule, die at childbirth or a few years afterward.

Blue Line on Gums.—Quite early in the course a peculiar bluish-black line can be observed on the gums, usually where they join the teeth. This is formed by the deposition of plumbic sulphide, and has been noticed in twenty-four hours after taking, medicinally, twenty grains of plumbic acetate, and for four years after exposure to lead had ceased. It can be traced first on the projections of the gum between the teeth, and in some cases, especially where the teeth have been very carefully attended to, it may appear there only. In a few instances it has not been observed at all, and it has once or twice been observed in mercury and silver poisoning; but, as a rule, it is the characteristic and distinctive mark produced by lead.

Intestinal Pains, "Colica Pictorum."—Soon after this the patient suffers from obstinate constipation, accompanied by acute paroxysms of pain in the abdomen. This pain is probably produced by the action of lead on the sympathetic ganglia of the intestines, and not by any inflammation of the intestinal walls. It can often be relieved by pressure, and is situated mostly around the umbilicus.

(*b*) *Nervous Symptoms.*—Besides the affections of the nervous system shown by the colic and by pains in various joints and muscles of the body, there are some characteristic nerve lesions due to a progressive peripheral neuritis. This sometimes produces an atrophy of the muscle along with a loss of power, but as a rule the parts affected are first partially or wholly paralyzed, and do not waste for some little time. This paralysis does not often attack a whole group of muscles, but picks out one or two here and there.

The muscles most affected are the extensors of the fingers and wrists, causing thereby a characteristic hanging of the wrist known as the "wrist drop." The corresponding leg muscles are occasionally affected, but almost always after the upper extremities, while the paralysis may spread to the upper arm and even attack muscles of the trunk. If the muscles are only paralyzed and not much atrophied, it is possible to make a complete cure by the aid of electricity and similar nerve stimulants, although relapses are common from even very slight exposures.

But when atrophy and paralysis occur together, recovery is very slow, if indeed possible at all.

Along with this paralysis there may occur more or less tremor, sometimes fine, like that of old age, and often very marked, like that of paralysis agitans, only of wider range and increased after motion or exertion. Sometimes this tremor affects the lips and tongue, and is much like that of mercury.

(*c*) *Cerebral Symptoms.*—Again, the poison may affect the brain, causing at first light symptoms of giddiness, headache, insomnia, disturbed sight and hearing, and the like, which may develop into delirium or into stupor, with coma and sometimes convulsions, especially before death. Sometimes the cerebral symptoms may result in attacks resembling those of epilepsy.

The disturbances of sight are quite common, and seem to depend upon an optical neuritis produced by the lead, as well as upon retinitis that may result from the kidney disturbances. The eyesight may be affected after only a few days' exposure.

Beside these there may be mental disturbances, melancholia, for instance, and hallucinations and delusions, generally mild, but sometimes acute. Occasionally there is mental failure, while, especially in France, there have been described cases of plumbic hysteria which counterfeited many of the most severe forms of nervous lead symptoms.

Cause of Death.—Death, as a rule, results from the general anæmia and malnutrition produced by the poison, and especially from its action upon the kidneys. Sometimes, however, the patients die in an acute cerebral attack, and occasionally from a paralysis of respiration or circulation. The treatment is the same as that already described under acute poisoning.

Location of the Poison in the Tissues.—The amount of lead found in the body after death is generally extremely small. It has been found chiefly in the liver and kidneys, though small quantities have been traced in the brain, stomach, spleen, and lungs, in man, and in the bones and muscles also, in a dog.

Excretion of Lead.—The poison absorbed into the system is undoubtedly excreted chiefly by the kidneys, although the actual amount of lead present in the urine is usually very small. Excretion is helped by the ingestion of potassium iodide, which tends to dissolve the lead. It is probably also excreted by the bile, and perhaps by the skin and intestines. The elimination is, as a rule, extremely slow.

Tests for Lead.—(*a*) *Sulphureted Hydrogen.*—This gas when passed through an alkaline, neutral, or moderately acid solution of lead will give a black (or, when the amount of metal is extremely minute, a brown) precipitate of plumbic sulphide. This precipitate can be reduced to metallic lead by heating on charcoal with the blow-pipe. It is soluble in dilute nitric acid and also in hot concentrated hydrochloric acid, which changes it into lead chloride. If other metals are present the mixed sulphides can be separated from each other by dissolving the arsenious sulphide with ammonia, and the antimonious sulphide with sodium sulphide. If the residue is treated with hot, strong hydrochloric acid, the lead will be dissolved and the copper or mercury compound remain behind. The lead chloride thus obtained, if in any abundance, will precipitate, on cooling and diluting with water, in the form of white crystals.

The test is extremely delicate, and, according to Wormley, will give a distinct brownish tinge to ten grains of solution containing, in all, 1–25,000 of a grain of plumbic oxide.

(*b*) *Sulphuric Acid.*—A solution of lead is readily precipitated by dilute sulphuric acid, or by a soluble sulphate, in the form of white, needle-shaped crystals of plumbic sulphate. This precipitate is soluble in a large amount of alkali, and also in hot concentrated hydrochloric acid.

(*c*) *Potassium Iodide.*—This reagent gives a yellow precipitate of plumbic iodide, soluble in caustic potash and in strong hydrochloric acid; it also dissolves in boiling water, and will be deposited from this solution in the form of yellow hexagonal plates, quite similar to crystals of iodoform.

(*d*) *Potassic Bichromate.*—This will precipitate the lead as yellow plumbic chromate, soluble in potash and in strong hydrochloric acid.

Separation of Lead from the Tissues.—If lead alone is being looked for, it is generally best to extract it from the organic material by repeated treatment with concentrated nitric acid. As a rule, however, the tissues are oxidized, as in the case of the other metals, with hydrochloric acid and potassic chlorate, and the mixed sulphides are precipitated from the acid solution by sulphureted gas. The lead sulphide can be extracted by hydrochloric acid and reprecipitated by sodic sulphate in the form of plumbic sulphate, which can be separated and weighed. To prove this to be lead it is possible to dissolve the sulphate in an alkaline carbonate and reprecipitate it by sulphureted hydrogen.

It is important to remember that lead, in minute quantities, has frequently been found in the body when there has been no suspicion of either acute or chronic lead poisoning; so that, unless the quantity found is comparatively large, or some at least of the characteristic symptoms have been present, it is not right to lay too much stress upon the analysis alone.

VIII. MERCURY, Hg.

Mercury is occasionally found free in nature, but is generally extracted by reducing and subliming the red sulphide, cinnabar. It is, at ordinary temperatures, a bright, metallic, heavy liquid, freezing at −39.9° C, and boiling at about 350° C. It is volatile at all temperatures, to a greater or less extent. It dissolves readily in hot concentrated sulphuric acid, and in cold nitric acid.

Physiological Effects.—Metallic mercury, when taken in single large doses, is, as a rule, quite harmless. Cases are on record where as much as two pounds have been administered, either at once or in the course of one or two days, and no toxic symptoms have resulted. On the other hand, in one or two cases where large doses were taken, enough of the metal has been absorbed to produce slight but distinct marks of poisoning.

When administered in minute doses for a considerable length of time the mercury becomes absorbed into the system, and then produces its characteristic effects. This is equally the case when given by the stomach or through the skin, or when inhaled as a vapor.

When the doses are very minute mercury seems to act as a tonic to the blood, and thus to the general system. In somewhat larger quanti-

ties it acts as a mild purgative by stimulating the flow of bile from the liver, and is much used, along with calomel, for this purpose. Besides this it has a well-known specific effect in the early stages of syphilis, counteracting both the specific lesions and also the general depressing effect, anæmia, weakness, and the like, of the disease.

Poisonous Effects.—(*a*) *Mouth Symptoms.*—The first signs that the drug has been pushed to its limit as a medicine consist of a slight redness about the gums, a smell to the breath, and a slight gray deposit at the base of one or more teeth. The teeth feel long, and are tender when tapped or struck, and there is a slight excess of saliva.

If the mercury is pushed still further true poisonous symptoms set in. The gums and tongue are swollen and sore, and bleed very freely. The teeth get loose, the saliva is enormously increased in quantity and becomes thick and ropy, and the breath is excessively offensive. The salivary glands become inflamed, and the soft parts of the jaw may even become ulcerated, and bleed more or less constantly. In some cases there is a necrosis of the jaw itself; and in all cases the general discomfort, sleeplessness, loss of blood, and bad condition of the tissues produce great weakness and emaciation, and sometimes may even cause death.

(*b*) *General Symptoms.*—These large doses of mercury always impair the general health and nutrition of the body. The patient becomes anæmic, loses appetite, becomes emaciated and weak, and often develops ulcers, bed-sores, and the like upon various parts of the body. This has been called mercurial cachexia. The kidneys, also, are apt to become inflamed, although not as severely as in acute poisoning.

(*c*) *Nervous Symptoms.*—Very important effects are produced upon the nervous system, especially when the mercury has been absorbed slowly through the lungs. Cases of this are very common in persons working in mercury mines, in the manufacture of barometers and thermometers, in plating looking-glass, in furriers and hatters working in fur preserved by mercurial solutions, and others. These nervous symptoms sometimes occur without salivation, and occasionally after all exposure to the poison has ceased.

The most common and characteristic symptom is the mercurial tremor, which usually comes on slowly and gradually, although occasionally it may appear all at once, as after a fit of rage. It at first affects the face and tongue, though but slightly. Then it attacks the arms, especially the forearms, and finally the legs. At first it is only occasional, coming on most markedly after exertion, or when excited for any cause. The patient is not quite sure of his hands. They move by jerks, and not slowly and steadily. When he tries to drink he spills the water and is apt to miss his mouth, while after he has once taken hold of anything it is hard to let it go.

Then his legs fail to serve him well; it is hard to walk without assistance, and his limbs tremble and move without his control. His tongue is tremulous and his speech is jerky, hard to articulate and hard to understand. When once excited the tremor is hard to stop, and finally may continue all the time, only lessening, though not stopping entirely, during sleep. The muscles become weak, although not losing their power of reacting with electricity. These motor disturbances may increase to partial paralysis.

Along with this, or sometimes before it, there are some psychical

symptoms, i.e., the patients become irritable and sleepless, and find it hard to fix their attention on anything. They may even develop symptoms of mental disorder; sometimes they have hallucinations, or even outbreaks, as in mild forms of mania; other cases become extremely stupid, almost idiotic.

The sensation, also, is almost always more or less disturbed. Sometimes there is a tickling feeling on the limbs, even marked neuralgia. At other times there is more or less anæsthesia, sometimes over half the body, but generally in patches.

The eyes are very commonly affected, and there is occasionally more or less deafness, and even aphasia. Sometimes the disturbances are confined to some part of the body, one arm, or a foot, for instance, specially exposed to the metal. This, however, is rare.

Cases of Chronic Mercurial Poisoning.—A remarkable and often quoted instance of this chronic poisoning on a large scale is that of the British man-of-war, the *Triumph*, which, off Cadiz in 1810, stowed in her hold one hundred and thirty tons of quicksilver saved from a wreck. The packages broke, and, as the weather was hot, the ship was permeated with the vapor of mercury. In three weeks over two hundred men were ill with salivation, ulceration of the mouth, diarrhœa, and partial paralysis. Two men died of gangrene of the jaw and mouth, and three others of consumption, although they had not previously been suffering from that disease; while others lost teeth and pieces of the jaw, or suffered from more or less chronic nervous symptoms. Almost all the stock on the vessel died, cats, mice, a dog, and even a canary bird.

An interesting account is given by Dr. Adler (*Med. News*, 1891, vol. lix., p. 186) of five cases of chronic poisoning among workmen in a hat factory. One of these, a man of forty-five years, had worked for nine years in the factory and had been sick for over a year. He first noticed the usual signs of salivation, which, however, did not become very severe. Then his hands became tremulous and unsteady, so that he could not read his newspaper. His eyes, too, began to trouble him; black spots would dance before him, and they would keep twitching. His gait was next affected; he was unsteady on his feet and staggered as though intoxicated. Then his appetite failed; he lost his sexual power; he became emaciated, losing twenty-five pounds or so in six months, and he had occasional vertigo. There was a blue line on his gums.

Another of these patients was a boy of fourteen years, who had been in the shop one year and had not been affected until about four months before. He then began to lose his memory and to suffer from headaches; his breath was affected, and he had symptoms of salivation. In about a month's time he found it hard to walk; his feet felt heavy, like lumps of lead. He then found it hard to pick up things from the ground, was slow to drop a pencil when he held it, and so on. When he came under treatment there was a marked tremor, and much ataxia, especially in his arms and shoulders.

In another case (Dr. Thiroloix, *Gaz. des Hôp.*, 1891, vol. lxiv., p. 417) similar symptoms were produced, in an attendant in a shooting-gallery, by the fumes of the fulminate of mercury used in the cartridges. They are believed, also, to have been caused (Dr. Buckley, *Jour. N. Y. Med. Ass'n.*, 1884, vol. i., p. 127) by the use of rubber teeth-plates colored with cinnabar.

Nerve Lesions.—Some authors claim that the above nervous symptoms are due to the action of mercury upon the brain and cord. On the other hand, Letulle (*Archiv. de Physiol.*, 1887, pp. 301, 437) has observed degenerations of the sheaths of the peripheral nerves, although he claims that the axis cylinders remain intact. This would correspond with the action of other poisons, alcohol, arsenic, and lead, and would show that the effects are due to a progressive peripheral neuritis.

Mercurial Hysteria.—It is only proper to say, in this connection, that prominent neurologists of the Paris school claim that in many cases the nervous symptoms of chronic mercury, and also of lead, poisoning, are exaggerations of previously existing hysteria, and that, having produced no true nerve lesions, they may be cured by suggestion. They give instances not only of tremor, but also of mercurial hemiplegia, hemianæsthesia, amblyopia, and even of apoplexy, which, they state, are of an hysterical character, and, while not producing death, are often very hard to cure by ordinary treatment. They carefully distinguish these from other cases of severe nervous disease, which rapidly leads to paralysis and death, and which results from exposure, as in the mercury mines, to large amounts of mercury vapor.

A curious case of this sort is given, in great detail, by Dr. Letulle (*France Méd.*, 1888, part ii., pp. 1578, 1589), of a workman who was exposed to mercury fumes for ten years, and at last came down with moderately severe palsy in his arms. He returned to his work partially cured, after a six-weeks treatment at the hospital with the ordinary remedies, and kept on for five years more without much trouble. Finally, while at work, he was seized with violent tremors of all four extremities, fell down, found that he could not raise himself, and was carried out and driven to the hospital.

He presented very marked features of mercurial palsy, violent tremors in both arms and legs, anæsthesia in part of his arm, teeth blackened and striated (a symptom noted by many French authors), left eye somewhat affected. He was unable to walk without the greatest effort, and after such exertion his whole body was set trembling. But he was cured of all his nervous symptoms in four days, on the application by Dr. Letulle, with a certain amount of formality, of a tight rubber bandage round one arm, followed on the next day and the day after by the placing of a magnet upon his shoulder, and again on his thigh.

Besides the above reference, the reader is directed to another paper by Dr. Letulle (*Soc. Méd. des Hôp.*, 1887, vol. iv., p. 370), where numerous examples are given and references are made to papers by Charcot, Jean, and others, on the same subject.

Treatment.—In other countries chronic mercury poisoning is treated by less striking methods. In the first place, the patient must be prevented from absorbing more of the poison. The mouth symptoms, salivation and the like, are controlled by washes of potassic chlorate, and by small doses of the same salt taken internally. The nervous symptoms are, as a rule, much improved and in many cases cured by galvanic electricity, while the mercury in the system is removed by small doses, from two to three grains, of potassium iodide. This salt, in some obscure way, seems to dissolve out the mercury and eliminate it through the kidneys; but, if done too rapidly, it may, by throwing large quantities of poison into the blood, aggravate the symptoms.

Elimination of Mercury.—This is done principally by the kidneys, and also largely through the large intestine and the saliva. Mercury has been found, however, in the sweat, milk, bile, and, in fact, all the secretions of the body. It has been found in the urine half an hour after a hypodermic injection, and two hours after a dose of mercuric chloride, taken through the mouth.

Experiments on animals tend to show that when a single dose of a mercury salt has been administered, it will be eliminated from the body in a few days. When, however, a patient has been absorbing mercury for some time, it may remain in the system for months if not for years.

Calomel—Mercurous Chloride—Hg_2Cl_2.

This is formed by subliming mercurous sulphate with common salt. It occurs in commerce as a heavy white powder, insoluble in cold water. It is largely used in medicine, generally in small but occasionally in huge doses, as a purgative and liver tonic, and also as a diuretic.

As a rule it is too insoluble to produce any severe effects, and doses of an ounce and more act no more powerfully than those of a few grains. Occasionally, however, whether from some idiosyncrasy in the patient, some impurity in the medicine, or some change in its composition set up inside the body, quite small amounts of calomel, five or six grains, in some cases, have produced marked salivation and even death.

Corrosive Sublimate—Mercuric Chloride—Bichloride of Mercury—$HgCl$.

This is the most powerful and most important of the corrosive salts of mercury, among which are included other mercuric compounds, the nitrate, sulphate, and the like, and also "turpeth-mineral" and "white precipitate." These compounds, when taken in small doses for some time, will set up the constitutional effects of mercury described above. But when administered in any quantity, they have an irritant and even corrosive action both upon the mucous membranes with which they come in contact, and also upon the organs through which they are excreted.

Corrosive sublimate occurs in commerce as a white crystalline solid or powder, with a peculiar metallic taste, and soluble in sixteen parts of cold, and three parts of boiling, water. It can readily be distinguished from other salts, by forming a brilliant scarlet precipitate with potassium iodide; and even minute quantities can be identified by heating them in a small reduction-tube and moistening the white sublimate with a little iodide.

Symptoms, when taken Internally.—When swallowed in any quantity the patient notices at once the characteristic taste, and a sense of constriction about the throat. The throat and mouth become very sore and painful, and the mucous membranes look white and shriveled. This is soon followed by pain in the stomach, and then by nausea and violent vomiting, the vomited matter being frequently stained with blood. There is severe purging, often of bloody material, and the abdomen becomes painful to the touch. Sometimes there is profuse hemorrhage from the bowels, or, occasionally, from the stomach.

Along with these symptoms come those of marked collapse, a feeble,

rapid pulse, cold sweat, difficult breathing, faintness, stupor, and the like. There are often cramps in the extremities, thirst is intense, and the urine is scanty or even suppressed.

Time of Death.—Death may come on very rapidly from suffocation, owing to corrosion of the trachea and œdema of the glottis. As a rule, it results from collapse, in a state of coma, or preceded sometimes by convulsions, in the course of from one to three days. After this time the symptoms are more like those of dysentery, i.e., frequent bloody stools containing often shreds of bloody mucus, and accompanied with much straining. The kidneys are much affected, while the case is apt to be complicated with salivation, and even by the nervous symptoms due to mercury.

The shortest period of death in the case of an adult is given by Taylor as half an hour. He also quotes another case of death in three and a half hours. Protracted cases of six, eight, and ten days, or even of some weeks, are not rare.

Fatal Dose.—Not a few cases have been reported where adults have died from doses varying from five to ten grains, and Taylor states that, under favorable circumstances, death might result from doses of from three to five grains.

On the other hand, with proper treatment, patients have recovered from much larger doses. For instance, Dr. Lodge (*Brit. Med. Jour.*, 1888, part ii., p. 720) tells of a man who ran into his office ten minutes after drinking a solution of one hundred grains of bichloride. He had already drunk a pint of milk, and the doctor, after washing out his stomach with warm water and an emetic, and giving egg albumen, had him put to bed in hot blankets. He suffered from a slight collapse, and next day from dysenteric symptoms, but was all well in a fortnight.

Treatment.—Mercury forms insoluble compounds with albuminous bodies, and hence the best antidotes are milk and white of eggs. The stomach, of course, must be well washed out, and the symptoms, as they occur, treated with soothing drinks, morphine, and stimulants. It not infrequently happens that the symptoms improve for a while only to return with greater violence.

Post-mortem Appearances.—These show evidences of inflammation of the digestive tract, although not always of the same part. Usually signs of softening, congestion, and even corrosion of the mucous membranes are found in the mouth, throat, and stomach, and in the few cases where these are found nearly normal, the intestines, and especially the large intestine, are much involved. After a few days the kidneys become large and much congested, and the bladder is usually contracted and almost or quite empty. The liver is not affected as much as by some other poisons.

Other Irritant Mercurial Compounds.—Similar effects have been produced by somewhat larger doses of other salts of mercury, as, for instance, mercuric nitrate, white precipitate, and turpeth-mineral.

Mercuric nitrate has poisonous qualities, whether taken internally or externally, but little inferior to those of corrosive sublimate. It has, indeed, been used as a means of attempted poisoning.

The white precipitate, mercury-ammonium chloride, NH_2HgCl, is largely used as an ointment, and as such is a mild and easy form of administering mercury. Internally, however, it acts as an irritant, as, for

instance, in a case (*Brit. Med. Jour.*, 1885, part ii., p. 15) where a drunken man, drinking forty grains of it in water, was taken violently ill in half an hour, with great pain, vomiting blood freely, and passing bloody stools, and, in spite of treatment, died of collapse in five hours. A case of recovery from twenty grains, where the early symptoms of an irritant poison were complicated in two-days time by acute mercurial symptoms, is given by Dr. Sandberg (*Brit. Med. Jour.*, 1889, part i., p. 709).

Turpeth-mineral, a basic sulphate of mercury, $HgSO_4 2HgO$, has also been the cause of many accidents, especially when given to croupy children as an emetic. Cases have been reported (*Med. and Surg. Rep.*, 1884, vol. l., p. 93) where one dose of three grains caused severe intestinal symptoms, and two similar doses produced death. Death in an adult has been caused by forty grains.

External Poisoning by Mercuric Chloride.—It has long been known and quoted in the text-books that strong solutions or mixtures, ointments and the like, of corrosive sublimate might cause severe illness, and even death, if freely rubbed into a raw surface. The symptoms, too, in these cases much resembled those when the poison was swallowed.

Of late years, however, the bichloride has been used very largely as an antiseptic dressing, in solutions containing from one to ten parts in ten thousand; and, much to the surprise of the operators, it has been found that even such extremely diluted solutions are liable to cause serious and fatal illnesses, unless used with considerable care.

The most marked symptoms are an obstinate diarrhœa, not readily yielding to treatment, and in severe cases followed by dysentery, with severe straining, passing of blood and bloody mucus, and the like, and by death. Along with these are usually some signs of salivation and other mouth symptoms, and also, to a marked degree, of inflammation of the kidneys. On post-mortem examination there is found in the large intestine a peculiar diphtheritic inflammation, and the kidneys are much congested.

These cases were early recognized in this country by Dr. Peabody, who (*Med. Rec.*, 1885, vol. xxvii., p. 290) gave statistics of eleven cases of such poisoning which had occurred in the previous eighteen months at the New York Hospital. Seven of these cases were fatal. The poisoning is also quite common in obstetrical cases, wherever bichloride solutions are used to wash out the uterus, and in *Obstetrical Transactions* (1886, vol. xxviii., p. 281, and 1888, vol. xxx., p. 315) are to be found details of numerous cases, and also some interesting discussions on the subject.

It is generally agreed, at present, that when bichloride irrigations are used they must not be too strong, and the parts bathed must be well drained. They should never be given when the kidneys are at all affected at the start. They must be stopped directly any mouth or intestinal symptoms are noticed; and the bowels should be kept open as freely as possible, so as to promote the excretion of the mercury by means of the large intestine.

Tests for Mercury.—(*a*) *Sublimation of Metallic Mercury.*—If a substance containing mercury or one of its salts is dried, mixed with dry sodic carbonate, placed in a reduction-tube, and heated gently, there will form a ring of metallic mercury upon a cool part of the glass. This ring differs from the similar sublimates of arsenic and bismuth by being

composed of small, spherical, bright globules. If the quantity of mercury is very small it is best to do this sublimation in a little subliming cell, and to condense the metal upon a flat cover-glass, when it can be more easily studied under the microscope.

If a crystal of iodine be placed in the reduction-tube or the subliming-cell after the sublimate has formed, the latter will slowly turn yellow, and then scarlet, from the formation of mercuric iodide.

(*b*) *Reinsch's Test.*—If the metal is in solution, it is most easily extracted by adding hydrochloric acid to it and boiling it with a strip of bright copper. The gray deposit thus formed must be washed, dried, and heated in a small reduction-tube, and the sublimate of metallic mercury recognized, as before, by consisting of globules and turning red with iodine.

By careful manipulation Wormley has recognized, in this way, the presence of 1–500,000 of a grain of corrosive sublimate.

(*c*) *Gold Test.*—This test may be modified by using a strip of gold instead of copper. This will form an amalgam with the mercury, and the amount of the latter may be easily obtained by drying and weighing the amalgam, and then, after driving off the mercury by heat, weighing the gold.

(*d*) *Sulphureted Hydrogen.*—This gas will give a deposit of mercuric sulphide, a black powder, insoluble in caustic alkalies, alkaline sulphides, and hot or cold nitric or hydrochloric acids. It dissolves readily in aqua regia, with separation of the sulphur as a yellow, sticky mass.

This sulphide, dried at 110° C, and weighed in a filter of known weight, is a convenient form for determining the quantity of mercury.

Tests for Mercuric Chloride.—If it is desired to test for corrosive sublimate it is best to boil the suspected substance well with water, and strain and filter it; and then to shake the filtrate with ether, in which the bichloride is soluble, and the common alkaline chlorides are not. The ether can then be allowed to evaporate, and the chlorine in the residue determined with argentic nitrate. It is possible, also, to recognize the crystals of the bichloride under the microscope.

Separation from the Tissues.—This is best done, as in the case of the other metals, by disintegrating the tissues with hydrochloric acid and chlorate of potash, and precipitating the metal as sulphide. This can be tested, as before, for mercury, or may be dissolved in aqua regia, evaporated to dryness, taken up with water and hydrochloric acid, and reprecipitated with sulphureted hydrogen and weighed.

It should be remembered in this connection, that mercury, in acute cases, leaves the body quite rapidly by means of the kidneys, liver, mouth, and intestines, and, according to some of the best authorities, may be absent from the body in the course of four or five days. It would probably be found in the liver and kidneys after it had disappeared from the stomach and even the intestines.

Nor, on the other hand, should the presence of mercury in a body be considered of much importance unless strong evidence could be obtained that the metal had not been administered as a drug for, at any rate, several days, if not several weeks or months, before. It is not uncommon to find mercury present in cadavers, and it is not known how long after a prolonged course of mercury traces of it may still remain in the system.

IX. COPPER, Cu.

The above element, in a more or less pure state, was probably the first metal ever made use of by man.

Occurrence.—It occurs, sometimes in large quantities, native, but is usually extracted from its ores, carbonates and oxides, and especially the more or less impure sulphides, of copper. In small quantities it is very widely distributed in the mineral kingdom, being found in many minerals, rocks, and soils, and also in many natural waters. From these it gets into plants, and has been found, sometimes in considerable quantities, in certain special varieties of flowers grown on soils in copper regions, and in minute traces, in most common vegetables and cereals.

It has been often found in wheat, barley, etc., and hence in bread, and also in roots like turnips, mangels, and the like, as well as in the leaves and stems of these and many other plants. It has been recognized, too, in drugs, such as quinine, and in quite large amounts (Gautier) in the inferior grades of chocolate and cocoa. Hence it is absorbed into animals, and besides being constantly present in the blood of lower animals, it is frequently, if not always, present in the flesh and organs of ordinary food animals and of man. Taylor tells of finding copper in a mutton chop bought at random at a butcher's shop, and Dupré, Bergeron, and others have found it, generally in weighable quantities (one thirtieth of a grain or so), in the livers, as well as the kidneys, of many human corpses which they examined.

Properties.—Copper is a reddish, heavy metal, melting at a high temperature, soft, malleable, and ductile. It has a metallic taste, and some odor. In moist air it slowly tarnishes, becoming covered with oxide. It dissolves in hot sulphuric acid, forming cupric sulphate or blue vitriol, and sulphurous oxide. It is easily soluble in nitric acid, and although more slowly, in hydrochloric acid and ammonia, especially if air be present.

Toxicology.—From the earliest ages metallic copper has been used for making pots and kettles in which articles of food were to be prepared. Homer, for instance, describes the great copper bowls offered as prizes to the Grecian heroes in their games. And in the Bible there are not only, in Exodus, descriptions of the sacred "vessels of the altar, the pots, and the shovels, and the basins, and the flesh-hooks and the firepans" being made of "brass," but also, in the Book of Leviticus, directions are given about meat "sodden in vessels of brass."

Nor was any objection made either then, or by the Greeks and Romans, or through the long middle ages, to any poisonous properties of the metal thus used until the eighteenth century, when in 1722 one Schulze published a book about it. His arguments were attacked and refuted by Dr. Eller, a very prominent physician, some thirty years later, but soon afterward were repeated, with embellishments, by J. J. Rousseau, the half-crazy, egotistical "philosopher of reason," who was at the height of fashion in France at the time. Thanks to him, a battery of iron cooking-utensils was made for the royal family, and this example was followed by many prominent members of the court.

In England the fashion of objecting to copper cooking-utensils dates from 1774, when Dr. Falconer, a well-known physician, published a book

on the subject in London. Ever since the beginning of the century copper has been under a ban. Almost all the prominent authorities on the subject of poisons, from Orfila and Tardieu to Taylor and Wormley, in every country, have accepted the statements of Rousseau, Falconer, and the rest as true, and have added further evidence. In some countries legislation has been invoked occasionally against the use of copper saucepans and the like without tinning, and frequently against the preparation and sale of vegetables, and other articles of food, containing perceptible traces of the metal.

This last matter has proved extremely serious in France, where enormous quantities of small vegetables are put up in cans and glass, and where for a long time the manufacturers have been accustomed to obtain the fine green color, resembling the natural appearance, by the use of small amounts of copper. Accordingly the subject has been thoroughly investigated of late years, and proof has been presented, both by French and Belgian scientific men, that the toxic effects of copper have been enormously exaggerated, and that neither copper itself nor its compounds are to be considered as poisonous, except when in very large doses.

Among the most interesting papers on this subject are those by Dr. Galippe (*Ann. d'Hyg.*, 1878, vol. l., p. 426; *Compt. Rend. Soc. de Biol.*, 1884, p. 718) and by Professor du Moulin, in the discussions on the poisonous properties of copper (*Bull. Acad. de Méd. Belgique*, 1885, vol. xix., pp. 753, 813, 859). Dr. Galippe made experiments, first on himself and later on his family and friends, for fourteen months, using in his kitchen nothing but copper utensils. He not only prepared fish and other salty food, and even acid foods like sauerkraut, in copper saucepans, but let them cool in them, exposed to the air, and partook of the results. In one case he prepared a sort of custard, made of sour milk and eggs, after a recipe furnished by an American doctor who reported a case of poisoning from it, and ate that.

In no single instance did he or any member of his family suffer any effects, although, as in the last-mentioned experiment, the food often looked and tasted strongly of copper. Indeed, he states that the taste of copper would make the food extremely unpalatable long before it would give symptoms of even nausea.

Dr. du Moulin thoroughly corroborates Dr. Galippe, having made experiments not only on himself and family, but also upon dogs and rabbits. Indeed, from these last experiments he states that it was impossible to kill dogs even with very large doses of copper salts, and that he doubts if copper or its salts can, under any circumstances, be considered as a poison.

A still more interesting view of the subject is given (*Jour. d'Hyg.*, 1879, vol. iv., pp. 160, 170) by Dr. Houlés, who studied thoroughly the conditions of life in a whole village full of copper-workers. The latter, descendants of English marauders, have for nearly five hundred years been engaged, from father to son, in rolling, hammering, and polishing copper boilers, kettles, and the like. They have long hours of work, eleven to thirteen hours a day, year in and year out, during which they are breathing an atmosphere full of particles of copper oxide. They have greenish lines on their teeth, green color in their hair, a green tinge on their forearms. Copper is found in their secretions, and even after death

their bones can be distinguished from those of the farming community near them by the green coloration.

Nevertheless, although not robust-looking they are strong and tough, suffer from no special diseases, and are unusually long-lived. Of three hundred and forty deaths occurring in the last hundred years among the copper workers, the average life was nearly sixty years (59.63), and forty died over eighty years old. The only peculiarities noticed were that they were almost all deaf, probably from the incessant noise of hammering; that those with weak lungs were apt to be troubled by asthma in the winter time, when the shops are badly ventilated; and that when the boys begin to work, at twelve or thirteen years old, there is apt to be a little vomiting, which wears off in a day or two. If they begin late in life they may have to give up work on account of the nausea and vomiting. This, however, is rare.

As a result of the discussion and investigation of the subject, the French Government, in 1889, revoked the laws about coloring peas and other vegetables by boiling them in copper vessels. And, in short, with all due respect to the many authorities who have claimed the contrary, it would seem as though it has been fairly proved that the absorption of small amounts of copper is not to be considered as dangerous, and certainly not as a cause of death. (For a case of this sort based on very slender evidence, see Taylor, *Guy's Hospital Reports*, 1866, p. 329.)

Cupric Sulphate—Blue Vitriol—$CuSO_4$.

This is the salt of copper most commonly met with in the arts and in medicine, and occurs as blue transparent crystals or crystalline fragments, slightly efflorescent, and readily soluble in water.

Symptoms.—Externally the compound acts as a mild stimulant or irritant. Internally, in doses from ten to fifteen grains, it acts promptly and rapidly, as a rule as an irritant emetic. In still larger quantities it acts as an irritant poison, producing in a short time nausea, vomiting, and purging, with bluish or greenish vomit and excreta and considerable pain and colic.

There are often quite marked nervous symptoms, convulsions, delirium, paralysis, and the like, or disturbances of sensation, while among later symptoms are apt to occur inflammation of the liver and kidneys.

The blood occasionally is very much affected, as, for instance, in a very striking case reported by Dr. Starr (*Med. Rec.*, 1882, vol. xxi., p. 564). A healthy woman, forty-six years old, took about an ounce of the salt dissolved in tea, for suicide. Almost at once she felt burning pains in her stomach and all over her body, and in a few minutes vomited and became very weak, with severe pains and cramps. She was given stimulants and emetics, and in two hours was taken to the hospital. She was then unable to walk or stand from weakness. Her pulse and respiration were good, her skin cool and dry; she complained of weakness and cramps in the stomach.

She was treated with stomach-pump, antidotes, purgatives, and milk diet, and improved next day. By the second day her stomach seemed in good condition, though the intestines were still inflamed, but she began to pass considerable amounts of dark inky urine containing much hæmo-

globin and black granular matter, some in the form of casts, with epithelial casts, kidney cells, and albumen. The third day she became jaundiced, and her urine remained the same, although in other respects the patient was better. But on the fourth day she was worse, became stupid, sleepy, with, later, general paresis, and after lying for several hours in a comatose condition died in four and a quarter days from the fatal dose.

Post-mortem examination showed that the blood, all over the body, was firmly coagulated, and of a chocolate color. There was only a little congestion in the stomach and upper part of the intestines, but the ileum and large intestine were considerably ulcerated and inflamed. The liver was fatty, and the kidneys were somewhat swollen, with tubules filled with altered blood. It was thought that death, and possibly the jaundice, had been caused by the alteration of the hæmoglobin.

This post-mortem appearance differs from those usually reported, not only in the condition of the blood, but also in the absence of more marked stomach lesions. This was probably due to the prompt and thorough treatment in the hospital.

Verdigris.

This, an impure sub-acetate of copper, is largely manufactured for paint, and is often formed in small quantities when sour or decomposing food is cooked or allowed to stand in copper vessels. Its effects are similar to, though less marked than, those of cupric sulphate just described. It is partly soluble in water, and wholly so in the mineral acids.

Antidotes and Treatment.—A very excellent antidote, if it can be obtained pure, is the yellow prussiate, or ferrocyanide, of potash, which forms a brown, inert precipitate with copper. The metal is also deposited, in a more or less insoluble form, by milk, white of egg, and other albuminous solutions. The treatment must be directed at the symptoms.

Dangerous and Fatal Doses.—These have not been accurately determined, and, as a rule, must be considered large, probably from half an ounce to an ounce. Medicinally, doses of from sixty to one hundred grains of the sulphate have been given to children, three to six years old, in cases of croup and the like, in the course of five or six days, without any evil effects beyond some vomiting and nausea, or perhaps a slight purging.

The shortest time of death yet reported is in the case of a child sixteen months old, who amused herself by chewing a piece of blue vitriol, given her to play with. She was violently sick in fifteen minutes, and died in four hours without purging and without convulsions.

Tests for Copper.—It is very easy to recognize the presence of copper, either free or in combination. The metal is easily dissolved by nitric acid, forming a blue solution, while the soluble salts are all either blue or green, and with the reducing-flame of the blow-pipe give fine green color to the flame.

(*a*) *Ammonic Hydrate* in excess changes these salts into a deep blue solution of cupric hydrate in ammonia. This reaction, in clear and not highly colored solutions, is very marked, and will serve to recognize very minute amounts of copper (1–10,000 of a grain of cupric sulphate—Wormley). Salts of nickel give the same reaction.

(*b*) *Ferrocyanide of Potash* forms, with solutions of copper, a reddish-brown precipitate; or, if the amount of metal is very minute, will give a reddish-brown color to the liquid. This precipitate is insoluble in acetic and hydrochloric acids, but dissolves to a pale green liquid in ammonia. This test is extremely delicate, even more so than the former one.

(*c*) *Iron Test.*—Simpler, and in some respects more satisfactory, than either of the above tests, is that made by placing a piece of bright iron or steel in a slightly acid solution of copper. The metal will then be deposited in a brownish or reddish film upon the iron, while the latter will be dissolved in corresponding quantities. In very dilute solutions the piece of iron should be very small, a needle, for instance, and in all cases the deposit should be tested, as, for instance, by immersing it in ammonia and exposing it to the air, and seeing if it gives a blue solution. The advantage of this test is that the copper is extracted in a metallic state.

(*d*) *Zinc Test, or Galvanic Test.*—If the solution containing copper be placed in a bright platinum dish and a piece of bright zinc immersed in it so as to touch the bottom of the dish, a spot of red metallic copper will be deposited on the platinum.

Or, instead of that, if a platinum electrode be placed in it and connected with the copper side of a battery, and the wire from the zinc side be connected with the dish, the copper in the solution will be deposited, in the course of twelve or twenty-four hours, upon the dish. If the dish containing this deposit be carefully washed, dried, and weighed, and, after dissolving out the copper with nitric acid, the platinum dish is again weighed by itself, the actual amount of the copper can be readily determined.

(*e*) *Sulphureted Hydrogen* will produce, in acid solutions, a brownish or brownish-black precipitate of cupric sulphide, which dissolves readily in hot nitric acid, and also, to some extent, in hydrochloric acid. It is slightly soluble in an excess of ammonium sulphide, but is insoluble in the fixed alkaline sulphides and in the caustic alkalies.

Hence, if present in the precipitate from passing the gas through solutions of arsenic or antimony, it can be separated by treating them first with ammonic hydrate, to dissolve the arsenious sulphide, and then with potassic hydrate, to dissolve the antimonious sulphide. The cupric sulphide remaining can be dissolved in nitric acid and reprecipitated by sodic or potassic hydrate as cupric hydrate, which can be washed, ignited, and weighed.

Or else the hydrate can be dissolved in dilute hydrochloric acid, and the copper precipitated, and weighed as metal, by the galvanic method above described.

Extraction from the Tissues.—Under these circumstances the organic matter should be thoroughly destroyed by boiling with strong nitric acid and potassic chlorate, and then by extracting, if necessary with repeated evaporations, with nitric acid. The excess of acid should be evaporated off, and the residues, which should no longer be black, should be dissolved in some hot water, containing, if necessary, a drop or two of acid. This solution can then be tested as already described.

X. ZINC, ZN.

Metallic zinc, and also the oxide of zinc, seem to have but slight if any effects upon the human system, and so our attention will be directed solely to the sulphate of zinc, or white vitriol, and to zinc chloride.

Zinc Sulphate—White Vitriol—$ZnSO_4$.

This compound, which occurs, when pure, in large, colorless crystals, easily soluble in water, and with a peculiar, styptic taste, is quite largely used in medicine. In weak solutions it acts as a mild astringent, and in strong solutions as a mild irritant. Its chief value, however, depends upon the fact that, in doses of twenty or thirty grains, it acts promptly and efficiently as an emetic, without much depression.

When taken in large quantities, half an ounce to an ounce, it may produce serious and even, on rare occasions, fatal results. As a rule, the symptoms are those of an irritant poison, and consist, chiefly, of violent and severe vomiting and purging, followed by prostration. Usually the poison is rejected so promptly by the stomach that fatal results do not occur, and recovery has taken place when an ounce and more of the salt has been swallowed; while if death does result, it is almost always after the lapse of some days, from the exhaustion produced by the inflamed condition of stomach and bowels.

Occasionally, however, a case is reported where the drug acts upon the central nervous system directly. Thus Dr. Penfold (*Austral. Med. Jour.*, 1883, vol. v., p. 340) tells of a girl, twenty-one years old, who on going to bed took a dose of zinc sulphate to produce abortion. Her mother was wakened in about three hours and a half by the girl's groans and screams, and started to get her some water, but in a few minutes the girl was dead. There was no evidence of vomiting or purging.

On post-mortem examination all the organs, heart, lungs, liver, brain, kidneys, and spleen, were found congested. The stomach contained half a teacupful of yellowish pasty material, which proved full of zinc, while the mucous membrane of the stomach was much congested, with large patches colored brownish black.

As an antidote to zinc it is well to give infusions of tannin, green tea, and the like, and also milk and solutions of albumen. Emesis should be assisted as much as possible by flooding the stomach with warm water, and by the use of the stomach-pump if necessary.

Zinc Chloride, $ZnCl_2$.

Chloride of zinc is a soft, deliquescent salt, very soluble in water, alcohol, and ether. When concentrated it is a powerful caustic, burning the tissues and leaving a white, odorless scar. Its solutions decompose rather readily, but are largely used, especially in England, as disinfectants, Burnett's fluid, one of the best known of these solutions, containing over fifty percent. of the dry salt.

In medicine it is largely used as a local caustic, for destroying tumors, cancers, and the like, and is considered to be more easily con-

trolled than potash, and far less dangerous than the different arsenical compounds. Occasionally, however, enough has been absorbed, in such a way, to cause death. Thus, in a case related by Dr. Blyth, a woman died after an application to a cancerous breast, and zinc was found in the liver.

Another case is recorded by Dr. Fifield (*New York Med. Jour.*, 1886, vol. xliii., p. 442), where a healthy farmer employed a neighboring "cancer doctor" to burn out a small cancer on his lip with a zinc chloride paste. Two hours afterwards the farmer became extremely drowsy and stupid, and had a slight epileptiform convulsion. Later he became comatose, and when seen in about four hours was lying on the bed unconscious, with complete anæsthesia, even of the eyeballs, with one pupil contracted and the other dilated. He was unable to swallow, and what treatment they could give him seemed of no avail. He died, still unconscious, in about eight hours after the application of the caustic. Nothing of any consequence could be observed on autopsy.

Internal Administration.—When taken internally, zinc chloride, if concentrated, acts as a caustic. In less powerful doses it produces acute inflammation of the digestive tract, and also certain nervous symptoms, twitchings, cramps, convulsions, affections of the eyesight, aphonia, and the like. Generally the symptoms much resemble those of acute mineral-acid poisoning, with intense pain in throat, stomach, and abdomen, violent and often bloody vomiting and, later, purging, and great prostration.

The patients die usually from collapse, as a rule in the course of one or two days, but occasionally in two or three hours. In other cases the patients recover at first, but die later from secondary complications, stricture of the œsophagus, duodenum, and the like.

In one very curious case (*Brit. Med. Jour.*, 1887, part i., p. 1387) a drunken laborer took for suicide three or four ounces of a saturated zinc chloride solution. He suffered terribly at first from pain and burning in throat and stomach, and with convulsions and epileptiform fits for the first two days, but gradually seemed to improve. He was fed for some six weeks by enemata, but then was able to take quite large quantities of milk and beef-tea, and from that time up to the tenth week he increased in weight and strength, although still suffering pain under the sternum. Then he grew weaker, and died of collapse at the end of eleven weeks.

Post-mortem examination showed that his stomach had been entirely destroyed, and had been replaced, for the few inches between the end of the œsophagus and the beginning of the duodenum, by an "irregular, sausage-shaped mass of organized, inflammatory, peritoneal adhesions," composed of a "matting of the gastro-hepatic omentum and the great omentum." It was some five inches long, and four inches in circumference, and the walls were in places very thin, and in other parts a half or three quarters of an inch thick.

In most instances the fatal cases reported have been due to persons accidentally drinking Burnett's fluid, or some other solution of the salt, and thereby taking from fifty grains to an ounce or so of dry zinc chloride. According to Blyth, death has been caused after several weeks' illness by six grains. The treatment would consist of the free use of emetics and of mild alkalies, and also of milk and albumen solutions. The collapse would be treated by stimulants and heat.

Post-mortem Appearance.—The principal lesions noticed are those resulting from the inflammation of the œsophagus, stomach, and intestines. The mucous membranes are usually much congested and inflamed, and may be ulcerated or corroded, or even perforated. Sometimes the membrane is much thickened and corrugated, and may have a yellowish color instead of red or black. In long-continued cases there is apt to be some thickening and constriction of the duodenum or pylorus.

Zinc Chloride in Canned Vegetables.—A solution of zinc in hydrochloric acid is not infrequently used instead of borax as a soldering fluid, and, when carelessly used in soldering the heads on cans of preserved vegetables and fruit, it is not impossible that it may cause harm.

An interesting case of this sort, which actually came into court, is described by Dr. Johnson in the *Sanitarian* (1884, vol. xii., p. 477), and discussed by him and Dr. Hammond with some vigor in the *New York Medical Journal* (1886, vol. xliii., pp. 370, 471). A family was taken sick, soon after eating a can of tomatoes, with severe gastro-intestinal trouble, which became very serious in the case of two members of the family, and caused chronic intestinal obstruction in the eldest daughter. The tomatoes were not spoiled, nor was the can a "sweller," i.e., one that had fermented, and had been repunched to let out the gas, reboiled, and then resoldered. On looking the question up, however, it was found that the heads had been soldered, with the use of zinc chloride, by a boy of thirteen years, with practically no experience.

Suit was brought against the wholesale grocers supplying the vegetables, but it fell through, because the Brooklyn Board of Health, who had taken charge of the case at the time, had never analyzed either the secretions of the patients or the remainder of the tomatoes, and had thrown the tin and its contents away.

Tests for Zinc.—*Blow-pipe.*—A zinc compound, heated on charcoal with the oxidizing blow-pipe flame, will, after the moisture has been driven off, form a white coating on the coal, and, unless heated too long, leave a yellowish-white residue. The latter, when heated with a drop of cobaltic nitrate by the reducing-flame, will, when cool, turn green.

Sulphureted Hydrogen.—When this gas is passed through an alkaline or neutral solution of zinc, it will form a white precipitate of zinc sulphide, ZnS, which is insoluble in alkalies and their sulphides, and also in acetic acid, but dissolves readily in the mineral acids. The same precipitate is produced by ammonium sulphide.

To prove the presence of zinc in the precipitate it is possible to dissolve it in nitric acid, and to add caustic potash in excess to this solution. The resulting precipitate of zinc hydrate, if melted on platinum foil with a drop of cobaltic nitrate, will give the green color as above.

The quantity of zinc can be determined by dissolving the sulphide in acid and precipitating it with sodic carbonate, boiling it thoroughly after the precipitate is formed. The zinc hydrate is then filtered, washed, dried, ignited, and weighed as zinc oxide, ZnO.

XI. SILVER—Ag.

Metallic silver seems to have no effect upon the human body, but one of its salts, argentic nitrate, or lunar caustic, as it is frequently called, is a violent poison.

Argentic Nitrate.—This compound crystallizes in the form of colorless, shining, rhombic plates, which have an astringent, metallic taste and dissolve freely in water. Either dry or dissolved, it turns black in the light when in the presence of organic matter. Its solutions are decomposed by hydrochloric acid or soluble chlorides into argentic chloride, a white, curdy precipitate, which dissolves in ammonia and turns dark in the sunlight.

Externally it acts as a rapid but superficial corrosive, turning the tissues first white and then black.

Internally it has an irritant, and even corrosive, effect upon the digestive tract, and besides, acts directly upon the central nervous system, producing convulsions, vertigo, coma, paralysis, and, above all, marked disturbances in respiration. The latter may be so severe as to cause death by asphyxia. If the patient survives for a few days there will be set up inflammation of the liver and kidneys.

Only three or four deaths have been reported in human beings from the action of this poison. From these it would seem that death has occurred from thirty grains; and in another case from fifty grains, in divided doses, in a woman aged fifty-one years. A child (fifteen months) died of convulsions in six hours, after swallowing a three-quarter-inch piece of a stick of lunar caustic.

As an antidote it is proper to give large quantities of salt and water, and also milk and albumen solution, to precipitate the silver. The symptoms must be treated as they occur.

An interesting case, where a valuable horse was poisoned by this compound, was investigated by Dr. Mott (*N. Y. Med. Leg. Jour.*, 1883-84, vol. i., p. 82), who isolated from the contents of the stomach the equivalent of nearly sixty grains, and from the liver, of thirty and a half grains, of argentic nitrate. The horse died quite suddenly, having, before death, "complete paralysis of the hind quarters, including the rectum and bladder," and on autopsy the stomach was found "highly corroded, and perfectly white on its inner surface," while the liver was a very dark, brown color.

Chronic Poisoning.—When small doses of this salt are taken internally for some length of time, until from one half to three quarters of an ounce of argentic nitrate have been absorbed, there is liable to result a peculiar bluish-black discoloration, first of the face, and later of the whole body. This is not necessarily accompanied by other symptoms, but is a very decided drawback to the free use of the salt for medicinal purposes. It is almost, if not quite, impossible to take away this color when once it has been produced.

Tests.—The use of nitrate of silver can usually be recognized by the white and then black stains upon the mouth, gums, skin, and clothing of the patient, without the deep corrosions of sulphuric acid. If the silver is in solution it is easy to precipitate and weigh it as chloride, by the addition of hydrochloric acid or common salt.

In the tissues, however, it usually exists as a chloride, and for that reason it is necessary, after destroying the organic matter with nitric acid and potassic chlorate, to extract with a solution of potassium cyanide and a little ammonia. This dissolves the silver, which can then be precipitated as chloride by an excess of hydrochloric acid. This chloride can be easily reduced to metallic silver by heating on charcoal with a blow-pipe, or by touching it with a piece of metallic zinc.

XII. IRON—Fe.

Although solutions of iron are constantly employed in medicine in considerable quantities, and are considered harmless, it is worth remembering that two of its salts, ferric chloride and ferrous sulphate, may, on occasions, act as severe poisons, and have even been used for murder.

Ferric Chloride, Fe_2Cl_6.—This compound is a brown deliquescent substance extremely soluble in water, and only met with dissolved in water or alcohol. Careful experiments have been made with it upon animals, in connection with a famous trial in Martinique (Bérenger-Férraud and Porte, *Ann. d'Hyg.*, 1879, pp. 312, 508), from which it would seem that, given with the food, it is practically harmless, but upon an empty stomach, and especially when dissolved in alcohol, it is an active poison. The symptoms noticed were those of gastric and intestinal inflammation, with suppression of urine, sometimes paralysis, and death generally in convulsions.

Effects upon Man.—The tincture of ferric chloride has occasionally been taken in large amounts by accident, and produced serious consequences. But in the case mentioned above it was used for murder, and actually killed four people. The victims were all French creoles living in Martinique, and successively devoted to a fair creole widow; while, in three of the cases, the symptoms of poisoning occurred shortly after drinking a glass of punch given them by the widow's son. The poison was, in each of these three cases, taken on an empty stomach, and produced violent pains in the abdomen, with either diarrhœa or constipation, with tenesmus, and with suppression of the urine. One of the patients died in about thirteen hours, and the other two in about sixty-five hours, while the fourth one, whose death was not as thoroughly traced as the rest, survived nearly four days.

Post-mortem Appearances.—The most noticeable appearance after death, in both animals and these men, was the blackish coating left on the mucous membrane of the mouth, throat, and stomach. The liver and kidneys were swollen and congested, and the brain and meninges were hyperæmic, and engorged with blood.

Fatal Dose.—The dose given in these cases could not be ascertained, but from other cases it is known that an ounce or so of the tincture, containing one and a third percent. of the dry salt, will produce, under proper conditions, quite serious symptoms on the stomach and kidneys. It is excreted through the urine, and probably also through the intestines, for the fæces are usually stained black.

Ferrous Sulphate—Green Vitriol—$FeSO_4$.—This salt occurs in commerce in the form of large, green, transparent crystals, with an astringent taste, and readily soluble in water. It is frequently used, in common with ferric chloride, as an abortive, and has occasionally been taken in dangerous or even fatal amounts by accident, and also, in rare cases, for suicide. An interesting example of this last is reported by Dr. Lucy M. Hall (*N. Y. Med. Jour.*, 1883, vol. xxxviii., p. 401), where a woman prisoner chewed and swallowed, on an empty stomach, about two ounces of the crystals. She soon became partially blind and deaf, she was dizzy, and her legs were partly paralyzed, so that she walked with difficulty. In four days she was brought to the infirmary suffering from

diarrhœa and severe pain in the abdomen, especially over the sigmoid flexure. Her stools were watery, greenish in color, and without any fæcal odor, her tongue was furred, her pulse was weak and irregular, her temperature low.

The intestinal trouble increased for two or three weeks, and developed, in some twenty-five days, into an exceedingly severe inflammation of the stomach as well as of the intestines. This nearly caused the death of the patient, but was finally subdued by injecting fifty-percent. solutions of plumbic acetate, containing some morphine, in four- and five-ounce doses, and keeping them in the intestines, by pressure, for two hours at a time. Under this somewhat heroic treatment the inflammation was finally controlled, and after two months the patient gradually began to improve.

In this case, as will be noticed, there was no particular effect upon the kidneys, and after the first few days the lesions were confined to the digestive tract.

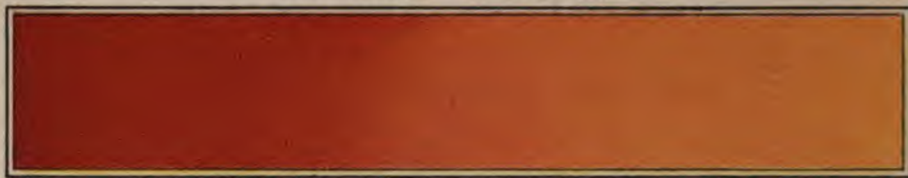
Tests for Iron.—It must be remembered that iron is a normal constituent of the blood and the red muscles of the body, forming an essential part of the hæmoglobin. Accordingly it is extremely difficult to distinguish, on chemical analysis, between the natural and the foreign iron.

According to Orfila—and his example has been followed by chemists since—the foreign metal can be dissolved by steeping the finely cut tissues, as well as the contents of the stomach and intestines, in cold acetic acid, which, it is claimed, has little or no effect on the iron in the hæmoglobin. The iron in the filtrate can be separated by ammonic sulphide, in the form of black, ferrous sulphide, and after dissolving in hydrochloric and nitric acids, may be reprecipitated by ammonia as brown ferric hydrate. The solution may also be tested with potassic ferrocyanide, which will form a blue precipitate, or, after nearly neutralizing, by adding ammonic sulphocyanide, which will turn the solution a deep red.

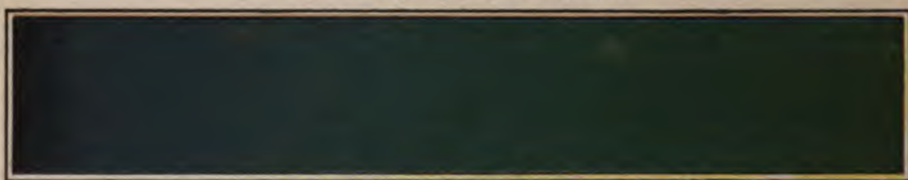
It would probably be easier and more satisfactory to obtain a good test for iron in the fæces, or especially, after death, from the black deposits on the mucous membranes of the stomach and intestines, than from the tissues themselves. Any stains upon the bedclothes or garments of the patient should also be carefully examined for iron.

Plate VIII.

No. 1. Atropine with Vitali's Test.



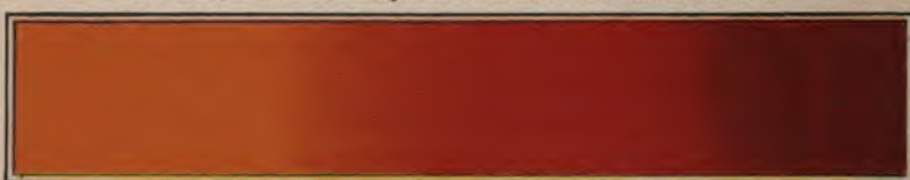
No. 2. Morphine with Nitric Acid.



No. 3. Morphine with Ferric Chloride.

No. 4. Morphine with Sulpho-Molybdic Acid.

No. 5. Strychnine with Sulphuric Acid and Potassium Bichromate.



No. 6. Veratrine with Sulphuric Acid

PAINTED BY DR. R. S. DOANE.

COLOR REACTIONS OF ALKALOIDS.

ALKALOIDAL AND OTHER ORGANIC POISONS.

BY

WALTER S. HAINES, A.M., M.D.

1. Alkaloidal Poisons.

The term alkaloid is used with somewhat varying significance by different authorities; but as commonly employed it refers to the bases or alkali-like bodies found in many plants, to which the latter as a rule owe their physiological effects. They are often spoken of as plant bases. The total number known is large, and embraces some of our most valuable remedial agents, and not a few of our most active poisons. There are many properties common to all, or to nearly all, of the different members of the class, and these may advantageously be considered together before taking up the individual substances.

Composition.—All alkaloids contain carbon, hydrogen, and nitrogen, and all but a few contain oxygen also. The major portion of them, therefore, do not differ from one another in the elements of which they are composed, but only in the relative proportion of these elements.

The chemical formulas of a few of the most important toxic alkaloids are as follows:

Aconitine	$C_{33}H_{43}NO_{12}$
Atropine	$C_{17}H_{23}NO_3$
Cocaine	$C_{17}H_{21}NO_4$
Colchicine	$C_{17}H_{19}NO_5$
Coniine	$C_8H_{17}N$
Gelsemine	$C_{12}H_{14}NO_2$
Morphine	$C_{17}H_{19}NO_3$
Nicotine	$C_{10}H_{14}N_2$
Strychnine	$C_{21}H_{22}N_2O_2$
Veratrine	$C_{37}H_{53}NO_{11}$

Physical and Chemical Properties.—Alkaloids containing oxygen are fixed solids, while those containing no oxygen are volatile liquids. They are generally crystalline, devoid of color, and are usually possessed of a bitter or pungent taste. The volatile alkaloids have a pronounced odor, but those that are fixed are odorless; they are generally of alkaline reaction to litmus, and combine with acids, neutralizing them and producing salts.

The free alkaloids are, as a rule, either insoluble or difficultly soluble in water, but they generally dissolve with readiness in alcohol, ether, chloroform, and benzine, and in many other organic liquids. Their salts, on the other hand, are usually readily soluble in water, especially when

slightly acidulated, and also in alcohol, but ordinarily they do not dissolve in ether, chloroform, or benzine. These differences in the solubility of the free alkaloids and their salts are taken advantage of, as we shall see later, in the extraction of alkaloids from complex organic mixtures.

Like the majority of organic substances, most of the alkaloids are unstable bodies, undergoing complete or partial decomposition under a great variety of conditions. All of them when heated considerably above the boiling-point of water, and sometimes at a much lower temperature, are prone to undergo change; as a rule, strong acids and alkalies and active oxidizing agents decompose them; and they all appear under suitable conditions to be acted on by micro-organisms, which eventually cause their complete decomposition. For these reasons it is highly necessary in extracting alkaloids not to subject the materials under examination to too high a degree of heat, nor, as a rule, to bring them in contact with strong acids, alkalies, oxidizing agents, or other powerful chemicals. Failure to observe these precautions can easily lead to negative results, even though an alkaloid be present in the suspected substance.

For the same reason, after death by poisoning by an alkaloid the latter sooner or later disappears from the body by decomposition. This is probably brought about chiefly through the agency of micro-organisms, which swarm in the decomposing body. It is very important, therefore, to examine for alkaloidal poisons as soon after death as possible; the longer the examination is put off, the smaller the chance of detecting the poison.

Most alkaloids when in solution are rendered insoluble and precipitated by a number of chemical compounds, which are known, consequently, as general precipitants or reagents for alkaloids. The most important of these are tannic acid, picric acid (Wormley's reagent), phosphomolybdic acid (Sonnenschein's reagent), iodine dissolved in a solution of potassium iodide (Wagner's reagent), and potassio-mercuric iodide (Mayer's reagent). The last two are usually the most valuable, and both are of great service as general tests for the presence of an alkaloid. If neither of these reagents produces a precipitate in a suspected solution, we generally say with great certainty that no alkaloid is present; if, however, they do occasion a precipitate, the presence of an alkaloid may be suspected, although not positively demonstrated, as several other substances are precipitated in a similar manner. These tests, therefore, have chiefly a negative value, but this is frequently of great importance. Wagner's reagent may conveniently be prepared by dissolving one part of iodine and two parts of potassium iodide in ninety-seven parts of water, and Mayer's reagent for qualitative purposes may be similarly made by dissolving one part of mercuric iodide and two parts of potassium iodide in ninety-seven parts of water. The precipitates given by Wagner's reagent are reddish or reddish brown, while those produced by Mayer's reagent are generally yellowish white.

Many of the alkaloids when subjected under appropriate conditions to certain chemical agents produce characteristic colors, and advantage is extensively taken of this fact in the recognition of a large number of the alkaloids. Such reactions are known as color tests. For example, if strychnine is treated with strong sulphuric acid, and a crystal of potassium bichromate, or other oxidizing agent, is drawn through the mixture, a very brilliant play of colors ensues, beginning with blue and ending

with red. Similarly morphine, colchicine, atropine, and many other alkaloids develop more or less characteristic colors when treated with different chemical reagents, especially those of an oxidizing character. As before stated, extensive advantage is taken of these color reactions in testing for the presence of alkaloids, and they are of the greatest utility in toxicological investigations. When properly conducted they are entirely reliable, and may be depended upon with great certainty; but if not performed with skill, or if the observer is decidedly color-blind, they may be worse than useless, and may lead to most unreliable results. In connection with the several alkaloids, hereafter to be considered separately, the color tests for each will be described, and the precautions to be observed in obtaining them dwelt upon.

Symptoms Produced in Case of Poisoning.—The alkaloids as a rule produce their poisonous effects rapidly; sometimes the symptoms begin immediately after their administration, and they are rarely delayed for any considerable length of time. After the toxic symptoms begin to show themselves they generally progress rapidly, with increasing violence, and unless relief is obtained death promptly ensues. There are many marked exceptions to this rule, especially in connection with morphine, whose effects are often slow in manifesting themselves, and sometimes persist many hours before leading to a fatal termination. Rapidity of action is somewhat characteristic of the alkaloids, and in a general way distinguishes them from most of the mineral poisons, which usually are slower in producing their effects. The poisonous alkaloids as a rule exert their chief influence upon the nervous centers, and the symptoms, therefore, in the main, are those referable to the nervous system. Perverted action of the heart and of the respiratory organs, disorders of vision, perverted sensation, convulsions, paralyses, and coma are among the most common symptoms shown. With a few exceptions, chiefly in connection with colchicine and veratrine, violent vomiting and purging are not usually seen, and in this respect alkaloidal poisoning differs from the toxic effects of most of the mineral poisons, which as a rule occasion pronounced emesis and diarrhœa. As the effects of the poisonous alkaloids are chiefly directed to the nervous system, the diseases with which they are likely to be confounded are naturally those in which the nerve-centers are involved, such as tetanus, epilepsy, apoplexy, hysteria, étc.

Treatment.—Since the alkaloids generally act rapidly, prompt treatment must be resorted to if favorable results are to be secured. As in all other cases of poisoning, the stomach should be evacuated, either by emetics, or by the stomach-pump or stomach-tube, and the organ thoroughly washed out with tepid water. In the absence of means of evacuating the stomach promptly, or even in connection with such means, substances should be given which will render the alkaloid less soluble, and consequently retard its absorption. The most valuable of these are tannic acid, and iodine dissolved in potassium iodide (the official compound solution of iodine of the pharmacopœia). Finely pulverized charcoal has also been highly recommended, and it undoubtedly may sometimes be useful by mechanically uniting with the poison and slowing its absorption. It has at least the merit of being harmless. After removing from the stomach whatever portion of the poison is still there, the treatment should be addressed to the constitutional symptoms; and as these are commonly produced through perverted action of the nervous system,

the remedies employed are usually those that exert an influence upon the nerve-centers, such as chloroform, chloral, ammonia, caffeine, alcohol, nitroglycerine, atropine, electricity, etc., according to the poison taken and the indications presented.

Post-mortem Appearances.—These are rarely, or perhaps never, entirely characteristic, although they are sometimes of considerable utility in enabling us to form an opinion as to the cause of death, when taken in connection with the symptoms, the results of chemical analysis, etc. As the alkaloids generally produce their effects chiefly upon the nerve-centers, it might be supposed that characteristic post-mortem appearances would be found in the brain and spinal cord; this, however, is not often the case, for death usually ensues before definitely marked structural changes visible to the unaided eye, or even discoverable by the microscope, can be produced. As a rule it is the absence of marked post-mortem appearances, rather than their presence, that points to death by toxic alkaloids.

Detection.—The discovery of inorganic poisons in the stomach or other part of the body is, with few exceptions, generally one of mathematical certainty, owing to their unalterable character, their ease of purification, and their definiteness of reaction. Such, however, is not the case with the alkaloids, as a rule. They are all more or less unstable, and their complete purification, especially when present in but small amount, is frequently difficult, and their recognition therefore by established tests is always laborious, and sometimes impossible; only by the use of skill and care at every step can positive results be gained. It should be stated, however, that one of the alkaloids, strychnine, in unalterability and definiteness of reaction approaches somewhat the inorganic poisons.

Many methods have been devised for the extraction of alkaloids from complex mixtures, such as articles of food, parts of the body, etc., but they are all based upon the method first suggested in 1851 by the eminent chemist, Stas, of Brussels. They all depend upon the fact that the salts of the alkaloids are soluble in water, but are decomposed in aqueous solution upon the addition of an alkaline substance which abstracts their acid and liberates the alkaloid; the latter is then precipitated, but may be removed by shaking with an immiscible solvent, such as ether, chloroform, benzine, or some other similar fluid, which extracts them from the watery mixture and retains them in solution. By evaporation of the liquid the alkaloid is left behind in a condition for further purification, and ultimately for testing. The various methods suggested for the extraction of alkaloids differ chiefly in minor details, and especially in the use of different immiscible solvents. In Stas's original method ether is used, in that of Rogers and Girdwood chloroform is employed, while in the method of Uslar and Erdmann amyl alcohol is the solvent recommended. In all cases, however, practically the same general method is pursued, which in its greatest simplicity is as follows:

The substance to be tested is finely comminuted and made into a thin paste with water, and an acid added in sufficient amount to impart decided acidity to the mixture. Acetic or tartaric acid is the one generally to be chosen when operating on the contents of a stomach, articles of food or vomited matter, but when examining tissues, such as the liver, kidneys, or brain, dilute sulphuric acid is sometimes preferable. The

acidulated mixture is gently heated on the water-bath one or two hours, with frequent stirring, and the occasional addition of a little water to replace what is lost by evaporation. By this treatment any alkaloid that may be present is converted into a soluble salt and passes into solution. The mixture is next strained through several thicknesses of fine cloth, and the insoluble material thoroughly washed with hot, acidulated water. The turbid fluid thus obtained is evaporated at a very gentle heat on the water-bath to a comparatively small bulk, and four or five volumes of strong alcohol are slowly stirred in. By this means a large number of foreign bodies, especially albuminoids and proteids, are coagulated and rendered insoluble, while the alkaloidal salt remains in solution in the alcohol. The mixture is now poured upon a paper filter, and the residue is thoroughly washed with hot alcohol. The combined alcoholic filtrates are evaporated at a very gentle heat on the water-bath to the consistency of a thin syrup, and when cold the extract is dissolved in four or five times its bulk of water slightly acidulated with sulphuric acid, and carefully filtered from any insoluble material that may have separated. The acid filtrate, which contains in solution in a small bulk all of the alkaloids originally present in the material tested, is now treated with about half its volume of ether and thoroughly shaken; upon standing a short time the ether rises to the top and is removed by a pipette, and the process may be repeated a second and even a third time, if deemed necessary. By this procedure considerable coloring matter and much other foreign material are removed, while the alkaloidal salts, as a rule, remain behind in the aqueous fluid. The ether, however, may extract, wholly or in part, certain substances (including a few alkaloids), such as picric acid, salicylic acid, digitaline, caffeine, colchicine, and delphine, which are sometimes of importance in toxicological examinations; the ether, therefore, should be allowed to evaporate in a large watch-glass, and the residue tested for the above bodies if their presence is suspected.

To the aqueous fluid an alkali is now added in very slight excess, such as ammonium hydrate, potassium hydrate, or sodium carbonate, the first being generally preferable, although sometimes one of the others is more useful. By this treatment the alkaloidal salt is decomposed, and the alkaloid set at liberty and precipitated. A double volume of chloroform, or, in case the presence of morphine is suspected, amylic alcohol is added, and the whole is vigorously shaken in a stout stoppered tube, flask, or separatory bulb. The mixture is set aside, when the chloroform settles to the bottom of the vessel and carries with it in solution the greater portion of any alkaloid that may have been present. By means of a pipette the aqueous fluid is drawn off, and again shaken with a double volume of chloroform, so as to insure the complete extraction of the alkaloid. The united portions of chloroform are evaporated in a large watch-glass at a gentle temperature, and the character of the residue critically observed. It occasionally happens that the alkaloid is left in a state of considerable purity, in which case the residue may be examined by various tests at once. Usually, however, it contains too much foreign material to permit the direct application of specific tests, and it must be purified by solution in dilute acid, filtration, neutralization, and reëxtraction with chloroform as before described. The residue from the evaporation of this chloroform is sometimes pure

enough for the application of the various characteristic tests for the individual alkaloids, but more often still additional purification is necessary. One of the best general methods of accomplishing this is to wash the residue on the watch-glass with a few drops of ice-cold water, repeating the operation, if necessary, two or three times. By this means considerable foreign matter is removed, while the alkaloid is left largely undissolved. It may now be once more dissolved in dilute acid, filtered, neutralized, and extracted with chloroform. Upon evaporating the latter, the alkaloid is generally obtained sufficiently pure for testing.

This process of purification necessarily entails the loss of more or less of the poison; but it should be borne in mind that a small amount of a pure alkaloid is far more readily and much more certainly recognized than a large quantity that is impure. The latter, indeed, may often fail to respond to any of the characteristic tests of the alkaloid present.

Upon shaking chloroform with the alkalinized fluid containing the suspected alkaloid, as directed above, it quite frequently happens that the agitation causes the chloroform to emulsionize. In this event its separation from the aqueous fluid is exceedingly slow and unsatisfactory. To remedy this, Allen has suggested substituting a mixture of equal volumes of chloroform and ether. This is an excellent solvent for most of the alkaloids, although not quite equal to chloroform alone; but as it does not emulsionize nearly as readily as the latter, it is often greatly to be preferred.

Many modifications of the above general method are necessary in special cases, and in connection with each alkaloid such departures as may be desirable will be noted.

Professor Dragendorff has suggested an exceedingly elaborate method for the extraction of alkaloids from unknown mixtures. Various solvents are used in his process, and an effort is made to separate, to a greater or less degree, any alkaloids that may be present into a number of groups, to aid in their subsequent recognition. While the method is of great value in plant analysis, and is sometimes of marked utility in testing parts of the body (especially when there is no clue to the poison used, or a number of drugs have been administered), as a rule it is unnecessarily cumbersome, and frequently, in my experience, gives less satisfactory results than the shorter and more direct methods.

It is scarcely necessary to add that whatever process for extracting the poison is selected, the most constant attention and painstaking care are necessary at every step. None but absolutely pure, tested chemicals should be employed, every utensil should be scrupulously clean, and all operations should be performed in a room from which poisons are excluded, and to which the analyst alone has access.

The total number of alkaloids known is large, but many of them are not toxic, and need not, therefore, be considered. Of the poisonous alkaloids, moreover, a considerable number are so rare and so seldom employed that they do not merit individual attention except in special treatises. For our purpose it will be sufficient to consider only the most important of the toxic alkaloids, as follows:

Aconitine, atropine, brucine, cocaine, colchicine, coniine, gelsemine, hyoscine, hyoscyamine, jervine, morphine, nicotine, strychnine, and veratrine. Some of these are rarely used in a pure state, either as medicines

or poisons, but the plants in which they occur may be extensively employed, and as their efficiency is due chiefly or entirely to the presence of the alkaloid, the latter has an importance which it otherwise would not possess.

ACONITE AND ACONITINE.

Aconitine (synonyms, aconitin, aconitina and aconitia) is the active principle of *Aconitum Napellus*, commonly known as monk's-hood or wolf's-bane. The alkaloid is found in all parts of the plant, but it occurs in the root in the largest proportion; the amount, however, found in the latter is exceedingly variable, ranging from less than 0.1 to 0.6 percent. In addition to aconitine, the *Aconitum Napellus* frequently contains smaller quantities of other alkaloids, which, however, are unimportant. Other varieties of the aconite plant, such as the *Aconitum ferox* and *Aconitum Fischeri*, owe their activity to alkaloids similar to aconitine, and differing practically so little from it as not to demand separate consideration.

Properties.—Aconitine when pure is a colorless, crystalline solid; odorless, but possessed of an acrid taste, which is followed by a characteristic tingling and numbness of the tongue and lips. As found in the shops it is exceedingly variable in appearance and strength; much of it is amorphous, and some of it has but slight activity, containing probably but little of the pure alkaloid. Pereira states that he took a grain of a French preparation without perceiving the slightest effect either locally in the mouth, or generally; and Wormley examined three German specimens, one of which contained only a trace of the alkaloid, and the other two none. In my own experience I have never found commercial aconitine wholly destitute of activity, but the difference in the strength of different samples is very great, some specimens being fully six or eight times as powerful as others.

Like most of the alkaloids, aconitine is sparingly soluble in water, but it dissolves readily in chloroform; in ether it dissolves very much less freely. It has decided basic powers, neutralizing acids to form salts, most of which are readily soluble in water and in alcohol.

Symptoms.—Poisoning by the alkaloid aconitine is a comparatively rare occurrence, but cases of poisoning by aconite or some of its preparations, such as the tincture, are not infrequent. In the latter case, however, it is the aconitine that produces the toxic effects quite as much as if the alkaloid had been taken in its pure state.

The symptoms produced by poisonous doses of aconite are in many ways peculiar, and are sometimes so characteristic that a diagnosis may be made from them alone. Immediately or soon after swallowing the drug there is a sense of numbness and a peculiar tingling of the lips, tongue, and throat; this is followed by a burning pain in the stomach, accompanied by nausea, and frequently by vomiting. Purging is also sometimes present. The tingling and numbness, at first confined to the mouth and throat, extend to other parts of the body, swallowing becomes difficult or impossible, and there is a partial or entire loss of voice; the vision becomes impaired, the body is bathed in cold perspiration, the heart's action becomes feeble and irregular, the face pale and shrunken; there is great prostration with entire loss of strength, and the extremities are cold and clammy. Sometimes there are delirium and convulsions,

and death finally takes place by syncope. Variations from the above symptoms are not infrequently seen, but in practically all cases the tingling and numbness about the mouth and throat are observed, and these especially characterize this form of poisoning.

External application of preparations of aconite have sometimes occasioned alarming symptoms and even death.

Period when Fatal.—Aconite when taken in sufficiently large doses usually produces death rapidly. One case is recorded in which it occurred within eight minutes, and many have been reported in which a fatal termination ensued within an hour. On the other hand, however, death may be delayed several hours, or even a number of days. Professor Mallet has reported a case in which death occurred at the end of four days.

Fatal Quantity.—As the aconitine of commerce frequently varies greatly in strength, it is not surprising that great differences have been noted in the doses necessary to produce death. Pure aconitine is probably the most actively poisonous substance with which we are acquainted; one sixteenth of a grain has occasioned death, and probably half of this quantity might prove fatal. Pereira records a case in which one fiftieth of a grain nearly occasioned the death of an elderly lady; and if administered hypodermically the alkaloid is even more powerfully poisonous than when taken by the mouth.

As the preparations of the aconite plant vary exceedingly in alkaloidal strength, it is impossible to state with any degree of accuracy their minimum fatal doses; twenty-five drops, however, of the tincture, and four grains of the extract, have proven fatal, although without doubt smaller quantities than these, if prepared from very active specimens of aconite root, might occasion fatal results. On the other hand, recoveries have occurred from comparatively large doses both of the alkaloid and of aconite. Some of these undoubtedly may have been due to the efficiency of the treatment pursued, while others may be accounted for by the inertness or slight activity of the preparation taken.

Treatment.—The stomach should be evacuated as soon as possible, either by the stomach-pump or by emetics, and tannic acid, or vegetable infusions containing it, and solution of iodine in potassium iodide may be administered with the hope of reducing the solubility of the aconitine, and therefore retarding its absorption. Heart stimulants should be freely employed, and of these ammonia, alcohol, nux vomica, and digitalis are the most useful; the latter has been highly recommended, especially when given hypodermically. In all cases the patient should be kept warm, artificial heat, if necessary, being applied to the extremities.

Post-mortem Appearances.—As is the case with most of the poisonous alkaloids, aconitine does not produce any decidedly characteristic post-mortem appearances. The stomach and intestines are generally more or less reddened, there is congestion of the lungs and liver, and an injected condition of the blood-vessels of the brain and its surrounding membranes. The right side of the heart usually contains more or less blood, and throughout the body the blood is generally dark in color, and abnormally fluid.

Tests.—Solutions of aconitine respond to the general reactions for alkaloids, being precipitated by tannic acid, picric acid, etc.; the precipitates thus formed, however, do not in any way distinguish it from other

alkaloids, nor does it produce any characteristic color reactions. In fact, there is no reliable chemical test for aconitine. The physiological effects, however, of the alkaloid are very marked and quite characteristic. If an exceedingly minute portion of it in solution is placed upon the lips or tongue a peculiar tingling and numbness of the part is observed, which may continue for a number of hours. As small an amount as 1–1600 of a grain is capable of producing a well marked effect. When administered to the lower animals very small quantities produce fatal results; the 1–3000 of a grain of pure aconitine injected hypodermically will kill a mouse within half an hour. These physiological effects are the tests chiefly to be depended upon in testing for the presence of the alkaloid.

Detection of the Poison.—*In the Contents of the Stomach.*—The material should first be carefully examined for the presence of any pieces of leaves, root, or bark, since the poisoning may have been produced by parts of the plant itself; in case such portions are discovered, they should be thoroughly cleansed and examined under a microscope, and also chewed between the front teeth to observe whether a tingling sensation is imparted to the tongue and lips. Whether parts of the plant are found or not, the contents of the stomach, finely comminuted if necessary, are treated with a small amount of acetic acid, very gently heated, and the general process described on page 418 then followed. The first chloroform extract should be dissolved in a few drops of water slightly acidulated with acetic acid, and a single drop placed on the end of the tongue, allowed to remain there for one minute, and then discharged. If no tingling or numbness is observed at the end of fifteen or twenty minutes, it is generally useless to proceed further; but if these physiological effects are manifested, a small amount of the same solution may be given hypodermically to a mouse, or some other small animal, and the effects observed. If aconitine is present, death will usually occur within an hour. Should these physiological tests show the probable presence of aconitine, what is left of the solution of the first chloroform extract should be filtered, the filtrate rendered alkaline, and again extracted with chloroform; the residue obtained upon evaporation of the latter should then be dissolved in very dilute acid, and the generic tests for alkaloids applied to secure in a general way confirmatory evidence of the presence of the poison.

In the Tissues.—The liver and kidneys are the organs in whose tissues aconitine is most likely to be found. To detect its presence, the organ should be finely subdivided, mixed with water to a thin paste, and moderately acidulated with acetic or tartaric acid. The process may then be conducted as directed above in connection with the contents of the stomach.

Owing to its exceedingly toxic nature, the smallness of the dose required to produce death, and the somewhat uncertain character of our present tests for its recognition, aconitine possesses rather more interest in legal medicines than most other poisons. It is one of the few substances which in the present state of toxicology might be criminally administered and leave no positive evidence of the crime; if a small but fatal dose of the poison were to be given, especially if it were administered hypodermically, the chances of its detection in the body after death would not be great.

BELLADONNA AND ATROPINE.

Atropine (synonyms, atropin and atropia) is the chief active principle of *Atropa Belladonna*, or deadly nightshade. It exists in all parts of the plant, but more especially in the root, where it is found in quantities ranging from 0.3 to 0.5 percent.

Properties.—Atropine is a colorless, crystalline solid, devoid of odor, and possessed of a bitter, acrid taste. It is sparingly soluble in water, but dissolves fairly readily in ether and very readily in chloroform; it has quite strongly alkaline properties, and completely neutralizes acids producing salts, most of which are soluble in water.

Symptoms.—Since atropine is the active principle of belladonna, the poisonous effects of the two are practically identical, the only noteworthy difference being, as would be expected, that the atropine as a rule acts more rapidly than the crude drug. A toxic dose of either occasions symptoms which vary somewhat, but are in the main as follows: There is great dryness of the mouth and throat, extreme redness of the tongue, difficulty in swallowing, wide dilatation of the pupils with impaired vision, and well-marked delirium; the latter is somewhat characteristic, being generally of a pleasing nature, although sometimes it assumes a maniacal form. Nausea is often, and vomiting occasionally, present. As the case progresses speech becomes difficult or impossible, there is great thirst, numbness of the extremities, partial or complete paralysis of the limbs, and frequently entire loss of sight. The pulse becomes feeble and rapid, and often intermitting; a deep red eruption sometimes appears on the skin; profound coma sets in, and death occurs, occasionally preceded by convulsions.

Atropine and belladonna exercise their poisonous effects however introduced into the system, and many cases are reported of toxic symptoms from their local application to the skin and to ulcers, and even when used about the eye or the ear. At least one case is reported of death from the external use of the alkaloid.

Period when Fatal.—The effects both of atropine and belladonna usually begin within an hour, sometimes showing themselves a few minutes after they are taken. Occasionally, however, no disturbance is shown for a considerable period, one case being recorded in which the first symptoms were delayed for five hours. After the effects begin to manifest themselves the progress of the case is usually slow, death rarely occurring before the end of a number of hours. In one case, however, it ensued in two hours, and in another in three and three quarter hours; and a surprising case is reported of death in five minutes after the hypodermic injection of a small amount of the alkaloid. On the other hand, the person may linger fifteen or twenty hours, and death may occur even as late as the second or third day.

Fatal Quantity.—Probably the smallest fatal dose of atropine recorded is one thirtieth of a grain given hypodermically; one twelfth of a grain by the stomach has also produced fatal effects; and a clyster of belladonna root, containing by calculation a sixth of a grain of the alkaloid, has occasioned death. On the other hand, recovery has taken place from quite large doses, both of the alkaloid and of the drug. Drs. Loomis and Wescott report cases in which complete recovery occurred after tak-

ing a grain of the alkaloid, and in other cases recovery has followed even larger doses, Dr. Eliot recording entire recovery after the ingestion of four grains of the sulphate. It is an interesting fact that although atropine is an exceedingly active substance physiologically, and sometimes, as indicated above, produces death in small dose, yet as a rule recovery takes place even from large doses, and often, moreover, without antidotal treatment; of thirty-two cases of poisoning by the alkaloid, collected by Dr. Eliot, only two proved fatal.

Treatment.—If seen early, the stomach should be thoroughly evacuated by the use of emetics or the stomach-pump, and at the same time chemical antidotes may be employed. Of the latter probably the best are tannic acid, solution of iodine, and finely pulverized charcoal.

Morphine should be administered, preferably hypodermically, in doses of from a quarter of a grain to a grain, and repeated from time to time if necessary to control the delirium. Pilocarpine by the mouth or subcutaneously has also been highly recommended. As the poison is eliminated largely by the urine, stimulating diuretics, like sweet spirit of niter, are sometimes useful, and the patient should be catheterized, if necessary, to avoid the danger of reabsorption of the poison from the bladder.

Post-mortem Appearances.—These are not usually characteristic, and occasionally no post-mortem effects are observable. The most common appearances are dilated pupils, redness of the tongue, and injection of the mucous membrane of the stomach and small intestines. The blood-vessels of the brain are usually congested, and there is often engorgement of the lungs. The heart is frequently empty, and the blood is generally liquid and of a dark color.

Tests.—Atropine responds to all of the general tests for alkaloids, giving precipitates with solution of iodine, picric acid, tannic acid, etc., but there is nothing in its behavior with these reagents which especially characterizes it, or distinguishes it from other alkaloids. We have, however, three tests which are characteristic, especially when taken in conjunction with one another; these are the physiological test, Vitali's test, and Wormley's test.

(*a*) *Physiological Test.*—Atropine when introduced into the eye of man, or into that of one of the lower animals, occasions marked dilatation of the pupil; this is produced by very minute quantities, and lasts for a considerable length of time, often persisting several days. The eye of the cat is particularly well adapted for this test, although that of man may be used without danger if proper precautions be observed, such as not using too large an amount, and taking pains to have the material employed and the instruments used for introducing it entirely aseptic.

This test is exceedingly delicate, and can detect even a smaller amount than the 1–100,000 of a grain. Hyoscyamine and hyoscine, which are, as we shall see further on, isomers of atropine, and which constitute with it a group of alkaloids known as the mydriatics, produce the same effect; hyoscyamine, in fact, is somewhat more energetic in dilating the pupil than atropine, and hyoscine is more powerful than either.

A few other substances also cause dilatation of the pupil, the most conspicuous of which are cocaine, and, to a less degree, digitalis and coniine; all of these, however, are far less energetic than atropine, and their effects are much more evanescent.

Selmi and other investigators have found that certain ptomaïnes pos-

sess mydriatic power closely resembling that of atropine, but the latter may be distinguished from them by other tests, especially by the one next to be considered.

(*b*) *Vitali's Test.*—If atropine is treated with a few drops of strong nitric acid, evaporated to dryness at a gentle heat, and the residue, which is colorless or slightly yellow, touched with a drop of alcoholic solution of potassium hydrate, a purple color is developed, rapidly changing to violet, then to dark red, and finally disappearing. (*See No. 1, Colored Plate.*) This beautiful and highly characteristic test responds to an exceedingly minute quantity of the alkaloid, considerably less than 1–50,000 of a grain giving a decided reaction.

The two isomers of atropine, hyoscyamine and hyoscine, produce the same reaction, but no other alkaloid gives an effect which could be mistaken by a competent observer for that of atropine. It has been claimed that veratrine gives a somewhat similar reaction, but I have been unable to verify the statement. Several specimens of the alkaloid of the best make, when examined by Vitali's test, have given only a brownish color.

Brouardel and Ogier have been unable to obtain an atropine reaction by this test from any ptomaïne which they have separated from the human body. It is a test, therefore, of great value. In the presence of much foreign material it sometimes fails to respond, and it is important, therefore, before applying it to the suspected substance, especially if the latter is an extract from a stomach or other organ, that it be purified as far as possible.

(*c*) *Wormley's Test.*—If a strong solution of bromine in hydrobromic acid is added to a solution of atropine, a yellow precipitate is produced, which is amorphous at first but on standing becomes crystalline. This test, discovered and introduced by Professor Wormley, is quite delicate, the 1–10,000 of a grain yielding good results. The test is also characteristic, for while most if not all of the other alkaloids give with the test yellow precipitates, they all remain amorphous with a few exceptions. Hyoscyamine and hyoscine give crystalline precipitates which cannot be distinguished from atropine, and meconine, one of the constituents of opium, also produces a crystalline precipitate, which, however, is distinguished under the microscope by its different crystalline form; meconine, moreover, is easily differentiated from atropine by not responding to either the physiological or Vitali's test.

Detection of the Poison.—*In the Contents of the Stomach.*—The material should be carefully inspected for pieces of leaves, root, or berries, which are often found in case the poisoning has been produced by eating parts of the plant. If such portions are discovered they should be thoroughly washed and examined under a lens to determine their exact character. Whether portions of the plant are found or not, the contents of the stomach should be finely comminuted, if necessary, acidulated with a small amount of acetic acid, gently heated on the water-bath for an hour or two, and the general process described on page 418 then followed. The first chloroform extract is rarely pure enough for the various tests, and it should be dissolved in a small amount of acidulated water and filtered; the filtrate should be made feebly alkaline and again extracted with chloroform. The residue obtained upon evaporation of the chloroform may now be subjected to the three tests above mentioned, beginning with the physiological test, which is best performed

as follows: a small portion of the extract is dissolved in a little water feebly acidulated with acetic acid, the mixture carefully filtered, gently boiled, and when cold one or two drops of the fluid taken up by means of a small sterilized pipette, and placed in the eye. The pupil should be carefully watched every few minutes and compared with the untreated eye, and if at the end of an hour no effect is shown, especially if negative results are obtained upon repeating the test, the absence of atropine may be definitely stated. If, however, dilatation is produced, the period of its duration should be carefully noted, and other portions of the chloroform extract should be tested by Vitali's and Wormley's tests. If the two latter also give positive results, the presence of atropine, or one of its isomers, is clearly established.

In the Tissues.—The organs to be tested, such as the liver, kidney, or brain, should be finely comminuted, mixed with sufficient water to make a thin paste, and acidulated with acetic or tartaric acid. The mixture is gently heated on a water-bath for an hour or two, and the subsequent process conducted as described above in connection with the contents of the stomach.

HYOSCYAMUS AND STRAMONIUM; HYOSCYAMINE AND HYOSCINE.

The two alkaloids hyoscyamine and hyoscine are the active principles of *Hyoscyamus Niger*, or henbane. Hyoscyamine is also found in small but variable quantities, associated with atropine, in belladonna, and it is the chief active principle of stramonium (*Datura Stramonium*), in which it is accompanied by a little atropine.

Hyoscyamine and hyoscine are isomers of atropine, having exactly the same atomic composition as the latter; they are, moreover, very similar in their chemical properties and physiological effects.

For convenience' sake the three are often spoken of collectively as the "mydriatic alkaloids," by reason of their effect on the pupil, which is more marked than that produced by any other substances.

On account of their close resemblance all three of the alkaloids, and the various plants from which they are produced, have essentially the same toxic effects; hyoscine, however, produces upon the system a more hypnotic influence, and has less tendency to occasion delirium than atropine or hyoscyamine. What has been said, therefore, concerning atropine and belladonna may be largely repeated in regard to hyoscyamus, stramonium, hyoscyamine, and hyoscine, the symptoms, treatment, etc., being practically identical. The alkaloids hyoscyamine and hyoscine respond to the same tests as atropine. They are to be extracted from the organs of the body in the same way as has been described in connection with atropine, and the same method of identifying them should be used.

Although the three alkaloids may be distinguished and separated from one another by a difference in the solubility of certain of their salts when there is a fair amount of material to operate upon, in toxicological examinations the quantity of alkaloid extracted is almost invariably so small that a positive determination as to which of the three it is, generally is impossible. We are usually, therefore, obliged to admit that the alkaloid extracted may be any one of the three.

This is sometimes a matter of considerable medico-legal importance, for an indictment alleging specifically the administration of one only of

these bodies could not generally be sustained if the chemical analysis alone were depended on. The presence of one of the mydriatic alkaloids might be clearly established, but it would generally be impossible to state absolutely which of the three it was.

COCAINE.

Cocaine is the active principle of *Erythroxylon Coca*, a shrub growing in various parts of South America. It exists chiefly in the leaves of the plant, combined with cocatannic acid and associated probably with one or two other alkaloidal substances, which, however, are of no great importance. The quantity of cocaine present in the fresh leaves ranges from 0.3 to 1.0 percent., the average being about 0.75 percent.; but upon being kept some time the alkaloid gradually disappears by decomposition, and the drug becomes inert.

Properties.—Cocaine when pure is a colorless, crystalline solid, sparingly soluble in water, but dissolving readily in ether, chloroform, and alcohol. The free alkaloid has only a slightly bitter taste, but its salts are decidedly bitter. It is of strongly alkaline reaction, uniting with acids, completely neutralizing them, and forming salts. Of these the one produced by its union with hydrochloric acid, and known, therefore, as the hydrochloride, hydrochlorate, or muriate of cocaine, is the one most commonly employed in medicine.

Symptoms.—In most of the reported cases of poisoning by cocaine the alkaloid has not been administered by the mouth, but has either been given hypodermically or applied locally to a mucous membrane, as that of the eye, the nose, or the urethra. However introduced into the system, if in sufficiently large dose it occasions rapid and severe disturbances. The symptoms frequently vary greatly in different cases, being modified probably by the quantity absorbed, the susceptibility of the individual, and the concurrent action of known or latent disease. The first effect shown is generally great nervous excitement, often attended with a sense of fullness and oppression in the head, and sometimes associated with nausea and vomiting. At first there is usually an increased frequency of the pulse and respiration, but this is generally succeeded by a marked diminution of both, especially observable in the breathing, which becomes slow and labored. The pupils are usually dilated, the extremities become cold, and the difficulty of respiration produces deficient oxygenation of the blood, which is shown by a cyanotic condition of the face. The pulse grows feeble, sometimes being imperceptible, the breathing becomes more and more labored, violent convulsions appear, succeeded by coma, and death generally follows from apnœa, although occasionally from cardiac failure. Many cases occur in which the symptoms differ from these in several respects; in some there is delirium, in others unconsciousness is present almost from the beginning, while in others the only prominent symptom is an intense sense of asphyxia.

Period when Fatal.—Cocaine generally acts with great rapidity, especially when given hypodermically or when applied to mucous surfaces. One case is recorded in which death occurred in twenty minutes, another in four minutes, and still another in forty seconds. Occasionally cases are somewhat more protracted, but generally if the patient survives half an hour recovery follows.

Fatal Quantity.—It is impossible to state definitely, in the present condition of our knowledge, the smallest fatal dose of cocaine, but it probably is not far from half a grain. Somewhat less than the latter quantity, given hypodermically, has produced death in at least one case, and one twentieth of a grain given hypodermically to a girl of twelve years has occasioned dangerous symptoms. Even as small an amount as the one hundredth of a grain in solution applied to the eye of a child fourteen years old has occasioned decided symptoms of poisoning. On the other hand, recovery has followed the administration of large doses of the alkaloid, such as twenty-two grains taken by the mouth, and ten grains given hypodermically.

Treatment.—If the poison has been taken by mouth, the stomach should be evacuated promptly by the use of an emetic or the stomach-pump, and at the same time tannic acid, iodine, or charcoal may be administered as possible chemical antidotes. In the great majority of cases of poisoning by cocaine, however, the alkaloid is given hypodermically, or has been absorbed from some mucous surface, and in these instances evacuation of the stomach is naturally unnecessary. The constitutional symptoms should be combated by the use of stimulants such as alcohol and ammonia, given by the mouth or by hypodermic injection. Inhalations of amyl nitrite and hypodermic injections of nitro-glycerine are often signally useful; and inhalations of pure oxygen are very valuable in relieving threatened asphyxia. In case breathing ceases, artificial respiration should be resorted to, and electricity may be tried, with some chance of favorable results.

Post-mortem Appearances.—No characteristic post-mortem appearances follow cocaine poisoning. The blood is generally dark and fluid, and there is likely to be congestion of the lungs and other internal organs, but it is scarcely necessary to say that these are not peculiar to death from this cause.

Tests.—Cocaine responds to all the general tests for alkaloids, giving precipitates with tannic acid, picric acid, solution of iodine, etc., but these are not distinctive, nor unfortunately do we possess at the present time any one characteristic test for the alkaloid. The following reactions, however, taken conjointly, will usually serve to identify it:

(*a*) *Permanganate Test.*—If to a fairly strong solution of a salt of cocaine a few drops of a solution of potassium permanganate are added, beautiful violet-colored crystals of cocaine permanganate are formed and precipitated.

(*b*) *Ferric Chloride Test.*—If cocaine in solution is boiled for a few minutes with dilute sulphuric acid, it is decomposed with the formation of benzoic acid. If the liquid is now neutralized by the careful addition of potassium hydrate and a few drops of ferric chloride solution then added, a pale brownish yellow precipitate of ferric benzoate is produced.

(*c*) *Odor Test.*—If cocaine is treated with fuming nitric acid, evaporated to dryness, and the residue treated with an alcoholic solution of caustic potash, a strong odor like that of peppermint is evolved.

(*d*) *Physiological Tests.*—If a solution of cocaine is introduced into the eye of man or one of the lower animals, it causes marked dilatation of the pupil, much resembling the effect produced by atropine and the other mydriatic alkaloids. The mydriasis, however, following the application of cocaine differs from that occasioned by atropine in requiring for its

production a very much larger dose, and in being comparatively evanescent, disappearing completely in a few hours' time.

Another and more characteristic physiological effect of cocaine is the local anæsthesia succeeding its application to the tongue, lips, or other mucous surfaces. The action is transient, the effect disappearing usually in from ten minutes to half an hour.

Detection of the Poison.—If the poison is sought for in one of the tissues of the body, such as the liver or kidneys, the part should be finely comminuted, mixed with water to a thin paste, and acidulated with acetic or tartaric acid. If vomited matter or the contents of a stomach are to be tested, the material should be made fluid with water, and acidulated as above. The mixture in either case is digested on the water-bath at a gentle heat for an hour or two, strained, and the general process for the extraction and purification of alkaloids described on page 418 then pursued, chloroform being by preference the immiscible solvent employed. A part of the purified residue should be dissolved in a very little dilute acetic acid, and a drop applied to the lip or tongue, and the local effect observed; another drop should be placed in the eye of a cat, and the pupil watched for several hours. If the portion applied to the lips produces decided numbness, and the solution introduced into the eye of the cat occasions a somewhat fugitive dilatation of the pupil, we have reasonable proof of the presence of cocaine. The remainder of the purified residue should then be tested by the several other reactions for the alkaloid, and if they all give characteristic responses, the presence of cocaine is established.

COLCHICUM AND COLCHICINE.

Colchicine (synonyms, colchicin, colchichia, and colchicina) is the active principle of *Colchicum autumnale*, or meadow-saffron. The alkaloid exists in all parts of the plant in quantity ranging from 1.0 to 1.5 per-cent.

Properties of the Alkaloid.—Colchicine when pure is a white solid, which is usually amorphous, but which may be obtained in a crystalline form. It dissolves readily in water and also in ether, alcohol, and chloroform. It is neutral or very faintly alkaline in its reaction to test-paper, and it has but a feeble affinity for acids. Its taste is bitter and pungent.

Symptoms.—Colchicine is an active poison, as are also the various parts of the colchicum plant, to which it imparts its toxicity.

Cases of poisoning by the pure alkaloid are very rare, but the plant and its pharmaceutical preparations have not infrequently caused death.

The most characteristic effects produced by both the plant and the alkaloid are those in connection with the gastro-intestinal tract, the poison producing symptoms somewhat similar to those of the mineral irritants, such as arsenic and antimony. There is severe burning pain in the stomach and bowels, violent nausea and vomiting, profuse purging, intense thirst, extreme prostration, feeble and rapid pulse, cold extremities, and great exhaustion. The nervous system is rarely or never involved; convulsions do not occur, the intellect remains clear, and consciousness may last up to the end.

Period when Fatal.—Although the toxic symptoms presented by large doses of colchicum are very severe, the drug does not generally

lead to a fatal termination rapidly. In one case death occurred in seven hours, but usually a much longer period intervenes. Of five fatal cases of poisoning by wine of colchicum reported from the convict hospital at Toulon, France, two died at the end of nineteen hours, a third after twenty hours, a fourth in twenty-two hours, and the last twenty-nine hours after taking the fatal dose. Still longer periods are reported in other cases, two being recorded in which death occurred on the fourteenth day.

Fatal Quantity.—Colchicine is a very active poison, and one third of a grain may be regarded as a probably minimum fatal dose. Casper records a case of death from wine of colchicum which contained somewhat less than half a grain of the alkaloid, Wood states that death has been occasioned by two and a half drams of the wine, and Taylor mentions a case in which three and a half drams proved fatal.

On the other hand, recovery has occurred after the ingestion of large doses, such as an ounce of the wine of colchicum and three fourths of a grain of the pure alkaloid.

Treatment.—In poisoning either by colchicum or its alkaloid, the stomach should be thoroughly evacuated and washed out as soon as possible. This may be accomplished if, as usually is the case, the patient is already vomiting, by the copious administration of tepid water to promote emesis; but if vomiting has not occurred an emetic should be given, or the stomach-pump used; tannic acid may be administered at the same time with a hope of diminishing the solubility of the poison, and therefore of retarding its absorption. After complete evacuation of the stomach, an opiate should be administered to allay the pain and check the vomiting, and ammonia, alcohol, and other stimulants may be freely used to counteract the depressing influence of the poison.

Post-mortem Appearances.—These are by no means characteristic, nor are the same appearances found in all cases. The stomach and bowels sometimes show intense congestion, but on the other hand these organs occasionally present an almost normal appearance; the lungs, the membranes of the brain, and the kidneys, however, are nearly always congested, and the blood is generally thick and dark colored.

Tests.—(*a*) *Nitric Acid Test.*—Colchicine when treated with nitric acid gives a bright violet color, which after a time changes to brown and finally to yellow. If the alkaloid is first treated with sulphuric acid, and to the solution thus produced, after standing some time, a drop of nitric acid is added, the reaction above described is said to be produced more sharply and more characteristically. No other alkaloid treated with nitric acid gives the same reaction as colchicine.

(*b*) *Mandelin's Test.*—Colchicine gives with a sulphuric acid solution of ammonium vanadate (one part of the vanadate to two hundred of the acid) an intense green color, which rapidly changes to a violet brown. No other alkaloid that has been submitted to this reagent gives the same reaction. Arbutin, aloin, and chrysophanic acid, however, behave very much like colchicine, but they are clearly distinguished from the latter by not producing with nitric acid a violet color.

(*c*) *Zeisel's Test.*—If the alkaloid is dissolved in hydrochloric acid and ferric chloride added, upon boiling the liquid becomes green. If the fluid is now agitated with chloroform the latter takes up a part or all of the coloring matter, and sinks to the bottom.

(*d*) *Physiological Test.*—Colchicine if given to one of the lower animals produces marked symptoms, characterized by vomiting, purging, great prostration, and, if the dose is sufficiently large, death.

The experiments of Vulpian show that about one twentieth of a grain is necessary to produce marked purging in a rather large dog, and that one third of a grain is required to kill a medium-sized dog with certainty, although half that quantity occasions intense symptoms, and may prove fatal.

Detection of the Poison.—The material to be operated on should be finely subdivided, mixed with water to a thin consistence, mildly acidulated with acetic acid, and heated on the water-bath; the mixture should be strained, evaporated to a syrupy consistence, and several volumes of alcohol added; after filtration the filtrate should be gently heated to expel the alcohol, mildly alkalinized with ammonia, and shaken with twice its bulk of chloroform or ether. Upon evaporating the latter at a gentle heat, the colchicine is left in an impure form as an amorphous, colored residue. It may be purified by redissolving in a dilute acid, filtering, alkalinizing, and extracting as before with an immiscible solvent. The residue now obtained upon evaporation may be examined by the several tests before described.

During decomposition of animal tissues substances are not infrequently produced which behave strikingly like colchicine with all of the general tests, excepting perhaps Zeisel's test. In a well-known case of suspected poisoning from colchicum occurring in Paris a few years since, Brouardel and several other eminent scientists, who were called upon as experts, found during their investigations that ptomaïnes might be extracted from decomposing cadavers, which produced reactions with nitric acid and with Mandelin's test strikingly like those occasioned by traces of colchicine; and other investigators have obtained similar results on many occasions. Nothing, therefore, short of the extraction from the suspected body of a ponderable quantity of material giving all of the chemical reactions and physiological effects of the pure alkaloid, should be accepted as proof of the presence of the poison.

Resistance to Putrefaction.—The experiments of Ogier, director of the Laboratory of Toxicology at Paris, show that colchicine resists putrefactive processes to a considerable degree. Three dogs were poisoned by the alkaloid and buried for five and a half months; at the end of that time the remains were examined, and indisputable evidence of the presence of the poison was obtained in each case.

CONIUM AND CONIINE.

Coniine (synonyms, coniin, conine, conia, conicine, and conicina) is the alkaloid which imparts activity to *Conium maculatum*, the umbelliferous herb commonly known as hemlock. It is found in all parts of the plant combined with an organic acid, but it is most abundant in the fruit, where it exists in a proportion of between 0.5 and 2.0 percent.

The pure alkaloid is an exceedingly energetic poison, almost approaching hydrocyanic acid in its activity. But few cases of death, however, have occurred from the alkaloid, but poisoning by the plant and its various pharmaceutical preparations have not been infrequent. The herb

has occasionally been mistaken for parsley or other edible vegetables, and the great majority of deaths from coniine have occurred through this misapprehension.

Properties of the Alkaloid.—Pure coniine is a colorless, oily fluid, lighter than water, and possessed of an unpleasant odor resembling that of the urine of mice. It boils at 163.5° C., and is slowly volatile at ordinary temperatures. Unlike most of the alkaloids, it is fairly soluble in water, requiring about one hundred parts to dissolve it; and it is very easily soluble in ether and chloroform. It has marked alkalinity, readily uniting with acids forming salts. In contact with air it changes chemically, becoming dark-colored, and eventually being converted into a brown resin.

Symptoms.—As coniine is the active principle of conium, the effects produced by the two are identical, except that the alkaloid acts somewhat more rapidly and energetically than the crude drug. They both exercise a profound influence on the motor nerves, completely paralyzing them. This effect is first manifested in the extremities, but eventually the organs of respiration are affected, and death ensues from apnœa, the heart continuing to beat after the breathing has ceased. The symptoms usually observed are great muscular weakness, beginning in the arms and legs, inability to walk, profound lassitude, dilatation of the pupils, huskiness or loss of voice, embarrassment of breathing, and finally death from paralysis of the muscles of respiration. The intellect generally remains clear until, through deficient respiratory action, the blood becomes overcharged with carbon dioxide, when we may have unconsciousness accompanied by convulsions and delirium.

Period when Fatal.—Both coniine and conium act with rapidity, the symptoms setting in soon after the poison is swallowed, and generally ending fatally in from one to three hours.

Fatal Quantity.—One fifth of a grain of the alkaloid has produced serious effects, and a drop has occasioned alarming symptoms. This may be regarded as a probably minimum fatal dose.

Treatment.—The stomach should be thoroughly evacuated as soon as possible, and iodine, tannic acid, or charcoal administered with the hope of retarding the absorption of the poison. Stimulants should be employed, such as alcohol and ammonia, and, on theoretical grounds, strychnine has been suggested as a valuable antidotal agent. Electricity may be serviceable, and copious inhalations of pure oxygen are unquestionably useful.

Post-mortem Appearances.—Coniine does not produce any characteristic post-mortem appearances. Those seen are such as are commonly found after death by apnœa. The lungs are congested, the brain more or less so, and the blood is dark and fluid.

Tests.—Coniine is characterized by the following reactions:

(*a*) *Odor.*—The mousey odor of coniine is peculiar and exceedingly marked; one part of the alkaloid in 50,000 of water, according to Wormley, is recognizable by the sense of smell.

(*b*) *Hydrochloric Acid Test.*—If a watch-glass containing a small quantity of the alkaloid is covered with another glass on the under surface of which is a little hydrochloric acid, copious white fumes are produced by the union of the vapor of the two substances, and the coniine soon becomes a mass of white crystalline needles.

(c) *Butyric Acid Test.*—If coniine is treated with a mixture of potassium bichromate and dilute sulphuric acid, and gently heated, butyric acid is formed, and may be recognized by its characteristic odor.

(d) *Alloxan Test.*—If coniine is added to a solution of alloxan an intense purple-red color is produced and white needle-shaped crystals separate, which dissolve in solution of potassium hydrate with the production of a purple color and the development of a mousey odor.

Detection of the Poison.—The suspected material, whether the contents of the stomach or one of the organs, such as the liver or kidneys, should be finely subdivided, made into a thin paste with water, mildly acidulated with acetic acid, and gently heated on the water-bath; the mixture is then strained, the liquid evaporated to a small bulk, treated with four or five times its volume of strong alcohol, and filtered from the separated insoluble material. The filtrate is carefully heated to expel the alcohol, the residual liquid mixed with a little water, again filtered, the filtrate rendered alkaline by potassium hydrate, and vigorously shaken with twice its volume of ether. The latter, after separation from the aqueous fluid, is removed, placed in a large watch-glass, and put in a cool place. Upon evaporation of the ether any coniine that may have been present will be left behind as oily drops, which are usually more or less colored by the presence of adhering impurities. To purify before testing, the residue should be dissolved in dilute acetic acid, filtered, alkalinized, shaken with ether as before, and the ether again allowed to evaporate spontaneously from a large watch-glass. If an oily liquid is now obtained which exhales a strong mousey odor, it may be submitted to the other tests for the alkaloid. If all of them give unequivocal, characteristic reactions for coniine, the presence of the poison is established, but nothing short of the most absolutely perfect response to all the tests should be accepted as proof of the alkaloid. Numerous animal tissues and fluids, especially if somewhat decomposed, yield not infrequently, upon examination as above, compounds of an oily character, possessed of a mousey odor, fuming with hydrochloric acid, and otherwise comporting themselves somewhat like coniine. A number of cases are recorded in which the poisonous alkaloid was at first supposed to have been discovered, but a mistake was afterward proved to have been made. The analyst should under no circumstances regard the presence of coniine as established unless all of his tests agree in every respect with those to be obtained from the pure alkaloid.

There seems to be some evidence that coniine, or at least a substance that possesses most if not all of its properties, is at times actually produced in animal tissue by decomposition. In view of this fact, death from coniine poisoning should never be affirmed from the result of chemical analysis alone, unless the latter has been made immediately after death, and before decomposition, therefore, has set in.

GELSEMIUM, GELSEMINE, AND GELSEMIC ACID.

Gelsemium, the rhizome and roots of *Gelsemium sempervirens*, or yellow jasmine, owes its activity to the presence of a powerful alkaloid, gelsemine (synonyms, gelsemin and gelsemia). This was first obtained in the pure state and critically examined by Professor Wormley in 1870, who

also discovered in the drug a peculiar acid, to which he gave the name of gelsemic acid or gelseminic acid. For most of our knowledge concerning both of these substances we are indebted to the careful investigations of this eminent scientist.

Professor Wormley found, as a mean of several tests, that the root contains about 0.25 percent. of gelsemine and 0.5 percent. of gelsemic acid.

Properties.—(*a*) *Gelsemine.*—In the pure state gelsemine is a colorless, odorless solid, having an intensely bitter taste, and crystallizing with difficulty. It is a strong base, uniting with acids readily, forming salts. It is freely soluble in chloroform and ether, but requires 644 parts of water for its solution. The alkaloid is exceedingly poisonous, one eighth of a grain killing a cat in one and a half hours, and one sixth of a grain may be regarded as a fatal dose for man.

(*b*) *Gelsemic Acid.*—This is a colorless, odorless solid, nearly tasteless and highly crystalline; it has but feeble acid powers; it requires nearly 3000 parts of water to dissolve it, but it is readily soluble in ether, chloroform, and alcohol.

Gelsemic acid does not seem to have any well-defined physiological effects upon the higher animals, although it is very poisonous to frogs.

Symptoms.—Cases of poisoning by the pure alkaloid are not known, but the various pharmaceutical preparations of the root have often produced fatal effects; and several deaths are recorded from the eclectic preparation "gelsemin," which is probably the true alkaloid mixed with considerable foreign matter.

The symptoms observed in poisoning by gelsemium usually begin with a sense of bewilderment and unsteadiness, the vision becomes double, and frequently all external objects assume a yellow hue; there is difficulty in opening the eyes, the upper lids dropping almost, or quite, beyond control; the face becomes congested, the lips blue, the pupils dilated and frequently insensible to light; speech is labored, the lower jaw falls, and the mouth sometimes remains wide open; the pulse is small and feeble, and respiration is difficult. The mind is not usually affected until near the end, when convulsions may occur and coma set in. Death is produced by apnœa.

Period when Fatal.—Death from gelsemium poisoning usually occurs early, one case being recorded of a fatal issue within an hour, and several others within two or three hours; but on the other hand, death has been postponed until the seventh or eighth hour. Usually if the patient survives four or five hours recovery is highly probable.

Fatal Quantity.—We do not know surely the minimum fatal dose of gelsemium, but the smallest recorded amount that has produced death in an adult is a dram of the fluid extract. This quantity represents, according to Professor Wormley, about one sixth of a grain of pure gelsemine. Children are naturally much more susceptible, and one case is reported of death from a quantity of the tincture equivalent to twelve minims of the fluid extract.

Treatment.—The stomach should be evacuated as promptly as possible, and general stimulants freely administered. Electricity has been highly recommended, and inhalations of pure oxygen would undoubtedly be useful in the latter stages when symptoms of asphyxia begin to show themselves.

Post-mortem Appearances.—In the few cases in which post-mortem examinations have been made after poisoning by gelsemium, absolutely no characteristic appearances were observed. As would be naturally supposed, since death occurs from apnœa, the blood was found dark and fluid.

Tests.—1. Gelsemic Acid.—(*a*) *Fluorescence.*—If gelsemic acid is treated with a solution of a caustic alkali, like ammonium or potassium hydrate, it assumes a yellow color, and quickly dissolves, producing a highly fluorescent liquid. The fluorescence is very marked even with small quantities of the acid, one grain in 100,000 giving a distinct reaction. Several other vegetable substances are also highly fluorescent, so that this test is reliable only when taken in conjunction with others.

(*b*) *Nitric Acid Test.*—If gelsemic acid is treated with nitric acid, it dissolves to a yellow or reddish solution; on treating this with an excess of ammonia the color turns to a deep red.

(*c*) *Sulphuric Acid and Ammonia Test.*—Sulphuric acid slowly dissolves gelsemic acid to a clear solution; if a drop of ammonia water is allowed to flow into this, the gelsemic acid immediately separates in the form of crystalline needles.

These tests, taken together, distinguish gelsemic acid from other substances with which it might be confounded.

2. Gelsemin.—The alkaloid gives precipitates with most of the general alkaloidal reagents, but is characterized especially by the following tests:

(*a*) *Oxidation Test.*—Gelsemine when pure dissolves in sulphuric acid with little or no change of color; but if the solution is treated with an oxidizing agent, such as potassium bichromate, manganese dioxide, or cerosoceric oxide, a beautiful reddish purple color manifests itself.

(*b*) *Nitric Acid Test.*—Pure gelsemine dissolves in nitric acid to a colorless solution, which on spontaneous evaporation leaves a permanent bluish green stain. If this greenish residue is treated with a small quantity of sulphuric acid and an oxidizing agent, the reddish purple color described in the first test is developed, so that the same quantity of the alkaloid may be used for both of these reactions.

Both tests (*a*) and (*b*) are highly delicate, and are quite characteristic, especially when they are used conjunctively in the manner spoken of above.

Detection of the Poison.—*In the Contents of the Stomach.*—The finely comminuted substance should be acidulated with acetic acid, diluted with water if necessary, digested on the water-bath for an hour or two, and then strained. The strained liquid should be evaporated to a small bulk, treated with several volumes of strong alcohol, filtered, and the filtrate heated gently until the alcohol has been expelled. The fluid is now examined separately for gelsemic acid and gelsemine.

(*a*) *Gelsemic Acid.*—The acid liquid is shaken with twice its volume of ether, which takes up any gelsemic acid that may be present. The ether is carefully separated from the aqueous fluid, allowed to evaporate spontaneously, and the residue examined for the acid by the tests given above.

(*b*) *Gelsemine.*—The acid liquid, after treatment by ether for removal of gelsemic acid, should be rendered alkaline and shaken with chloroform. Upon evaporation of the latter, any gelsemine that may be present will

be found in the residue, and its presence may be detected by the tests already described.

Should the first chloroform residue be too impure for direct testing, it may be purified by solution in dilute acid, filtering, alkalinizing, and reëxtracting with chloroform. The residue from the evaporation of the latter will usually be sufficiently pure for the various tests.

In the Tissues.—The parts should be finely comminuted, mixed with dilute acidulated alcohol, heated gently on the water-bath, strained, the fluid evaporated to a small bulk, and the subsequent examination conducted exactly as in connection with the *contents of the stomach.*

Both gelsemic acid and gelsemine resist decomposition at least fairly well. Professor Wormley reports a case in which he was able four and a half months after death to extract both the acid and the alkaloid from the body of a woman who died from the effects of three teaspoonfuls of the fluid extract of gelsemium.

TOBACCO AND NICOTINE.

Nicotine (synonyms, nicotin, nicotia, and nicotina) is the active principle of *Nicotiana Tabacum*, or common tobacco. It exists in all parts of the plant combined with an organic acid, the amount varying greatly in different specimens, and ranging from two to eight percent., the average being about five percent.

Nicotine when pure is one of the most violent poisons with which we are acquainted, fully equaling, if not surpassing, hydrocyanic acid in its toxic powers; only a few cases of death, however, are recorded from the alkaloid itself, but tobacco in its various forms has often proved fatal.

Properties of the Alkaloid.—Nicotine when pure is a colorless liquid, slightly heavier than water, and possessed of a very penetrating odor, like that of tobacco, and of a burning, pungent taste. It boils at 250° C., and slowly volatilizes at ordinary temperatures. It is readily soluble in water, and dissolves with ease in alcohol, ether, and chloroform. It is highly alkaline, neutralizing acids completely and producing neutral salts. When exposed to the air and light it slowly becomes colored, and finally is converted into a brown resinous substance.

Symptoms.—Tobacco owes its effects entirely to nicotine, and the symptoms produced, therefore, by the plant are identical with those occasioned by the alkaloid, differing only in rapidity of action. Soon after taking a toxic dose of either the plant or the alkaloid, there is experienced a violent sense of giddiness, accompanied by great prostration, trembling of the limbs, severe nausea and vomiting, and frequently copious purging; the heart's action is disturbed, the pulse becoming rapid and feeble, and the respiration is difficult; the pupils are usually widely dilated, although sometimes contracted; the face becomes blanched, the lips blue, the extremities cold, and the respiratory act becomes more and more embarrassed; the intellect is clouded, convulsions often occur, followed by coma, and death takes place by apnœa, the heart continuing to beat after breathing has ceased.

The external application of tobacco to ulcers, and even to the sound skin, has not infrequently been followed by violent symptoms, and sometimes by death. Infusion of tobacco, used as an enema for medical purposes, has occasionally produced severe symptoms of poisoning, and in

a number of cases has proved fatal. The smoking of tobacco occasions decided symptoms of poisoning with persons not accustomed to it, and in not a few instances it has produced death. It is surprising, in view of the great prevalence of tobacco-smoking, that a greater number of fatal cases have not been recorded. The reason for this probably lies in the fact that during the combustion of the tobacco a large part of the nicotine is destroyed, only about one seventh of that originally present passing unchanged into the smoke. Its place is taken in the products of combustion by less poisonous pyridine bases.

Period when Fatal.—Pure nicotine acts with great rapidity, one case being recorded in which death occurred three minutes after its administration; and in the well-known case in which the Count de Bocarmé poisoned his brother-in-law, Gustave Fougnies, by this agent, the victim died in five minutes. A tobacco enema has próve fatal in one case in fifteen minutes, in another in eighteen minutes, and in a third in thirty-five minutes. On the other hand, a fatal termination has been delayed for several hours, and in one case at least, until the second day.

Fatal Quantity.—The pure alkaloid is an exceedingly violent poison; its smallest fatal dose, however, is not definitely known, although it is probably only a fraction of a grain. The plant is also actively poisonous to those not accustomed to its use, an injection of only thirty grains having proved rapidly fatal in one case, while somewhat larger doses have killed in a few other instances.

Treatment.—The stomach should be at once evacuated, and iodine and pulverized charcoal may be administered with the hope of retarding the absorption of the alkaloid; general stimulants should be given, electricity applied to promote the respiratory efforts, and inhalations of pure oxygen administered to increase the oxygenation of the blood.

Post-mortem Appearances.—The body after death from tobacco does not present any characteristic signs. The stomach is sometimes found exceedingly reddened, the membranes of the brain congested, the lungs engorged, the liver and kidneys congested, and the blood dark and fluid. None of these appearances, however, excepting the condition of the blood, are constant.

Tests.—Nicotine responds to most of the reagents for the alkaloids, such as giving precipitates with iodine, picric acid, etc. It is distinguished, however, from all of the other ordinary alkaloids, except coniine, by being an oily liquid, and not a crystalline solid, as vegetable bases generally are. It is further characterized by its peculiar odor and by the following tests:

(*a*) *Hydrochloric Acid Test.*—If a watch-glass containing a little nicotine has inverted over it another glass moistened with a drop of hydrochloric acid, white fumes are rapidly formed, and an amorphous solid is deposited on the watch-glass. This reaction distinguishes it from coniine, which under similar treatment produces a crystalline deposit.

(*b*) *Mercuric Chloride Test.*—If a solution of corrosive sublimate is added to a solution of nicotine, a white precipitate is produced, which at first is amorphous, but which soon becomes crystalline. Most of the alkaloids, coniine included, produce with mercuric chloride a white precipitate, but they are easily distinguished from that occasioned by nicotine by remaining amorphous. Strychnine alone of all the other alkaloids gives a crystalline precipitate, but this may be easily distinguished from

the crystals produced with nicotine by the fact that the strychnine crystals are insoluble in acetic acid, while those obtained with nicotine readily dissolve in that agent. Moreover, the crystalline forms of the two are different.

(*c*) *Iodine Test* (*Roussin's Reaction*).—If to a solution of nicotine in ether an ethereal solution of iodine is added, long ruby-red crystals are deposited, appearing within a few minutes if the nicotine solution contains one percent. of the alkaloid, but requiring several hours to form if the solution is quite dilute.

(*d*) *Physiological Test*.—If even a very small quantity of nicotine is placed in the bill of a small bird, the animal falls dead in a few seconds. Larger animals are affected similarly by proportionately greater doses; a drop put on the tongue of a cat proves fatal in one or two minutes. Smallness of fatal dose and great rapidity of action characterize nicotine, although coniine is almost equally toxic.

Detection of the Poison.—The method described under coniine should be followed in extracting nicotine. The residue obtained, if it has the physical properties of the alkaloid, should be submitted to the tests for nicotine just described, beginning with the physiological test. The same precautions should be observed in applying the tests, and in drawing conclusions from them, as have been laid down in connection with coniine, since substances are occasionally extracted from putrefying bodies that bear many strong resemblances to nicotine, and which can be distinguished from the latter only by the most painstaking comparative tests. Moreover, in examining a body for nicotine it should always be remembered that a large majority of men and a considerable number of women use tobacco habitually, and the detection in a corpse of a small quantity of the alkaloid would not necessarily be significant of death from this poison.

Resistance to Putrefaction.—The alkaloid resists decomposition to a marked degree, and it may be detected, therefore, in a body even after the lapse of a considerable period of time. One experimenter was able to find the poison in two dogs that had been buried in the earth for seven years, and it has repeatedly been found in animals buried for shorter periods.

OPIUM AND MORPHINE.

Opium, the inspissated juice of the poppy (*Papaver somniferum*), is an exceedingly complex substance containing a large number of constituents, such as alkaloids, gum, resin, oil, coloring matter, etc. Of these by all odds the most important are the alkaloids, to which opium owes entirely its remedial value and powerful toxic effects. The number of alkaloids in opium is large, about twenty having been already isolated, and it is quite likely that others, which have not yet been determined, may be present in small quantities. Of the alkaloids, decidedly the most important is morphine, which is present in somewhat varying proportions in different specimens, ranging from six to fifteen percent. The United States Pharmacopœia demands the presence of not less than nine percent. in opium in its normal moist state, and from thirteen to fifteen percent. in dried pulverized opium.

The most important other alkaloids in opium are narcotine, codeine,

[illegible] are precisely like [illegible] that they may be [illegible] as having from [illegible]

Pharmaceutical Preparations. — [illegible] of which the most [illegible] opium [illegible] being given:

[illegible]

[illegible] grains of sul- [illegible]

Properties of Morphine. — [illegible] crystalline [illegible] forming [illegible] water, requiring upward [illegible] ordinary temperature; it [illegible] dissolves with a [illegible] alcohol, especially [illegible]

Symptoms. — [illegible] produced by opium and [illegible] owing to its con- [illegible] stomach, usually [illegible] are those of [illegible]

[illegible] sense of lassitude and [illegible] an irresistible inclination [illegible] and this symptom [illegible] of opium poisoning. The [illegible] less and less frequent as the [illegible] exceeding two or three a [illegible] toward the end it becomes [illegible] complete insensibility [illegible] strongly contracted, although some- [illegible] dilated. The skin is cold [illegible] and the whole muscular system is relaxed. [illegible] becomes more difficult, and finally [illegible] the end comes unexpectedly [illegible] Convulsions are occasionally seen when [illegible] in children, this effect being probably due [illegible] effect of its thebaine.

The external application of opium or morphine to ulcers, abraded surfaces of the skin, and even to the sound skin, has not infrequently

been followed by dangerous symptoms of poisoning, and even by death. Administered by the rectum or hypodermically, fatal results have also not infrequently been produced.

Diagnosis of Opium Poisoning.—There are numerous diseases or conditions which are liable to be confounded with opium poisoning, the most important being apoplexy, uræmic coma, acute alcoholism, and poisoning by chloral or other narcotics. With a full knowledge of the history of the case and of the post-mortem appearances, we sometimes may make an accurate diagnosis, but from the symptoms alone it is probably impossible in any case to be absolutely certain. When, therefore, the history is somewhat obscure and the post-mortem appearances are more or less negative, we are obliged to depend almost exclusively on the results of chemical analysis to make an accurate diagnosis; and since, as we shall see later, the detection of opium or morphine in a body is attended with many difficulties, no conclusion can justifiably be reached unless the evidence from the chemical investigation is absolutely clear and unequivocal.

Period when Fatal.—Both opium and morphine generally begin to show their effects soon after their administration; sometimes the symptoms appear within a few minutes, and they are usually not delayed beyond an hour. Occasionally, however, they are much retarded in manifesting themselves, in one case no well-marked symptoms being observed until the eighteenth hour. After the poisonous effects have commenced to show themselves the case usually progresses somewhat slowly, the time of death being generally from six to twelve hours after the administration of the poison. Death, however, has occurred within forty-five minutes, and, on the other hand, it has been delayed until the end of fifty-six hours.

Fatal Quantity.—The average minimum fatal dose of opium for the healthy adult may be placed at about four or five grains, and that of morphine at about one grain. If, however, the person is feeble, death may be produced by a smaller dose, and children as a rule have a marked intoleration both of opium and morphine, a single drop of laudanum having produced fatal effects with very young children in several cases. Morphine if given hypodermically is much more toxic than when taken by the mouth, and a number of cases of death are recorded after the hypodermic administration of from one sixth to one half of a grain. Recovery, however, has not infrequently followed very large doses, such as one to two ounces of opium and two drams of morphine.

As is well known, the intensity of the effects of opium and morphine is greatly modified by a number of conditions, such as idiosyncrasy, disease, pain, and habituation to their use.

Treatment.—The stomach should be thoroughly evacuated as soon as possible. For this purpose the stomach-pump or tube is, as a rule, to be preferred to emetics, as the latter are often unreliable and sometimes entirely useless in this, as in most other forms of narcotic poisoning. Preceding the use of the stomach-pump or tube, tannic acid, solution of iodine, or pulverized charcoal may be administered with the hope of retarding the absorption of the drug, but these should never be depended upon to the exclusion of the evacuation of the stomach.

After getting rid of the contents of the stomach, atropine should be administered in small doses, repeated occasionally, until marked dilata-

tion of the pupil is secured, but its administration should not be pressed beyond this point. A strong decoction of coffee by the mouth or by injection into the rectum is undoubtedly of service as a heart stimulant, and caffeine may be used hypodermically for the same purpose. The patient should not be permitted to sleep, but should be kept awake at all hazards by flagellations, constant walking, and continuous conversation. Cold water may be dashed over the head and chest for the same purpose, and electricity is often found useful as a stimulant to the respiratory and circulatory centers. If the breathing cease, artificial respiration must be resorted to, and inhalations of pure oxygen are sometimes of service.

Post-mortem Appearances.—Those which are most commonly seen are congestion of the cerebral vessels, effusions in and about the brain, congestion of the lungs, and unusual fluidity and darkness of the blood. These appearances, however, are by no means constant, nor when present do they necessarily indicate death from opium.

Tests.—The two most important and characteristic substances in opium are its chief alkaloid, morphine, and its peculiar acid, meconic. Both substances are distinguished by well-marked reactions.

1. *Morphine.*—Many tests have been proposed, and nearly all of them are sometimes useful; but the four that are chiefly important are the nitric acid, ferric chloride, sulpho-molybdic acid, and iodic acid tests.

(*a*) *Nitric Acid.*—If morphine is treated with nitric acid it assumes a reddish yellow, or sometimes a brownish yellow color, which upon standing fades to a light yellow. (*See Pl. VIII., No. 2.*) The reaction is moderately delicate and fairly characteristic. Brucine gives with nitric acid a red color, but upon the addition of stannous chloride it is changed to purple, while that from morphine is unaffected, or nearly so. Quite a number of other organic substances, chiefly those of a gummy and resinous character, also produce a reddish color with nitric acid; but these substances are not crystalline, and therefore differ materially from morphine.

In applying the nitric acid test to a suspected substance extracted from a stomach or other part of a body, it is highly important, in order that any just conclusion may be drawn, that the material be crystalline and free from extraneous matter. I have repeatedly seen extracts from various organs of the body give with nitric acid a reaction which could not be distinguished from that produced by morphine, although not a trace of the latter was present; but in none of these cases was the residue crystalline.

(*b*) *Ferric Chloride.*—Morphine when treated with a neutral solution of ferric chloride or ferric sulphate produces a deep blue, slowly changing to a dark greenish blue color, which is destroyed by free acids, by alkalies, and by heating. (*See Pl. VIII., No. 3.*) The 1–10,000 of a grain gives a fairly marked reaction. Carbolic acid, salicylic acid, gallic acid, and some forms of tannic acid, also strike with ferric chloride a bluish color; but all of these are soluble in water or ether, by which they should be removed in the course of analysis from the suspected material, before the ferric chloride is applied. By taking this precaution the test becomes a valuable one. The blue color produced by ferric chloride and morphine is destroyed by nitric acid, and a reddish yellow mixture is produced, due to the action of the acid on the morphine; by operating in this way two tests for the alkaloid may be obtained from the same material.

No ptomaïne has been found giving a morphine reaction with ferric chloride, according to the observations of Brouardel and Ogier.

(*c*) *Sulpho-molybdic Acid.*—Sulpho-molybdic acid produces a beautiful and fairly characteristic play of colors with morphine—a fact to which attention was first directed by Froehde, and the test consequently bears his name. The reagent may be conveniently prepared by dissolving a milligram of molybdic acid in a cubic centimeter of concentrated sulphuric acid by the aid of gentle heat. When morphine is treated with this solution, a play of colors is produced, beginning with purple, changing to violet, passing through several other shades, and finally ending in a dark blue. (*See Pl. VIII., No. 4.*) The reaction is very delicate, and if properly employed is characteristic; a few glucosides and papaverine give a similar reaction, but as these should be separated from morphine by the process of extraction and purification, they need not be further considered. The test is likely to be interfered with, or even wholly prevented, by the presence of foreign matter such as is prone to accompany morphine when extracted from complex organic mixtures. Before applying the test, therefore, the substance under examination should be carefully purified as directed further on.

(*d*) *Iodic Acid.*—A solution of iodic acid if treated with morphine is deoxidized, its iodine is set at liberty, and imparts to the liquid a brownish color. If starch is present it is colored blue by the formation of iodide of starch; or if the liquid is shaken with chloroform, the latter by dissolving the iodine assumes a purplish color. This reaction, however, is produced by many other substances, and it is of value chiefly as a negative test, for which purpose it is often very useful.

2. *Meconic Acid.*—Meconic acid is, when pure, a white crystalline solid, somewhat sparingly soluble in cold water, but readily dissolving in alcohol. It is characterized for toxicological purposes chiefly by two reactions.

(*a*) Ferric chloride strikes with meconic acid and its salts a deep red color, which is not discharged by corrosive sublimate, nor by even a considerable excess of a free mineral acid.

Sulphocyanates, such as are found in saliva, and which may therefore be present in the stomach, also strike with ferric chloride a deep red color, but the color thus produced is readily discharged by corrosive sublimate, which clearly distinguishes it from the reaction of meconic acid. So, too, strong acetic acid and most of its salts give with ferric chloride a red color; this, however, is destroyed by the free mineral acids much more easily than that produced by meconic acid.

(*b*) When treated with a solution of lead acetate a yellowish white precipitate of lead meconate is thrown down; this is insoluble even in a large excess of acetic acid, and upon being treated with ferric chloride it strikes a deep red color. These reactions combined are highly characteristic of meconic acid.

Numerous other acids, such as sulphuric, phosphoric, sulphocyanic, tannic, citric, etc., either in the free state or combined as salts, when treated with lead acetate give white or yellowish white precipitates; but the latter all differ from the precipitate produced with meconic acid, either in being soluble in excess of acetic acid, or in failing to give a red color with ferric chloride.

Detection of the Poison.—*In the Contents of the Stomach.*—If opium or one of its pharmaceutical preparations is believed to have been taken,

we examine for both meconic acid and morphine; but if suspicion points to the use of the pure alkaloid, we naturally test for morphine alone. As meconic acid is found in opium only, the detection in the stomach of this substance is as positive evidence of the administration of opium as the discovery of morphine; and since its reactions are sometimes somewhat more delicate than those for the alkaloid, we should not omit searching for it.

If, in an unknown case, both meconic acid and morphine are discovered, we know that opium or one of its preparations must have been administered; but if morphine alone is found, the alkaloid must have been used.

The contents of the stomach should first be critically examined for the presence of bits of undissolved opium, and the odor should be carefully observed, as the presence of opium and its different preparations often betrays itself by its peculiar smell. The material should then be finely comminuted, moderately acidulated with acetic acid, and digested on the water-bath for half an hour or an hour. The mixture is filtered, the filtrate evaporated to a small bulk, three or four volumes of strong alcohol slowly stirred in, and the separated insoluble material removed by careful filtration. The filtrate should be evaporated to expel the alcohol, and the syrupy residue dissolved in water acidulated with acetic acid. After filtration a slight excess of lead acetate is added, by which a precipitate is produced containing any meconic acid that may be present in the form of insoluble lead meconate. The mixture is thrown on a filter and the precipitate thoroughly washed with water. We now have two portions to examine—the material on the filter for meconic acid, and the filtrate for morphine.

1. *Contents of the Filter for Meconic Acid.*—While still moist the precipitate is removed, diffused through water, and a stream of hydrogen sulphide passed through the mixture to saturation; the lead salts will be converted by this process into black insoluble sulphide, while any meconic acid present will go into solution. The mixture is filtered and the filtrate evaporated to a small bulk; a part of the liquid is treated with ferric chloride and the remainder with lead acetate, and if from both we get the characteristic reactions already described, the presence of meconic acid is demonstrated.

2. *The Filtrate for Morphine.*—Hydrogen sulphide gas is passed through the fluid to saturation to remove the excess of lead acetate by converting the lead into the insoluble sulphide. The mixture is set aside in a warm place for a number of hours until the sulphide has subsided, and the fluid is then separated from it by filtration. The filtrate is evaporated at a gentle heat until all odor of hydrogen sulphide has disappeared; it is then placed in a stout test-tube, a slight excess of ammonia added, and a double volume of hot amylic alcohol immediately poured in and violently shaken. Upon standing, the amyl alcohol, which now contains the greater portion of any morphine that may have been present, rises to the top, and may be removed by means of a pipette. The aqueous fluid should be again shaken with amylic alcohol, which after separation may be added to the first portion; the combined amylic alcohols are now evaporated at a gentle heat on the water-bath in a large watch-glass, and the residue is to be carefully examined under a low power of the microscope. If much morphine is present, crystals will often be seen in greater

or less abundance; but whether crystals are found or not, the residue should be very carefully purified and thoroughly freed from extraneous matter. The presence of impurities is always liable to lead to confusing results when operating for any alkaloid, and this is particularly true when testing for morphine. To effect this purification the residue may be dissolved in a little dilute acetic acid, the mixture filtered, the filtrate alkalinized, and shaken at once with a double volume of hot amylic alcohol as before described. Upon evaporating the alcohol in a watch-glass, if morphine is present in more than small traces it will now usually appear, partially at least in crystalline form. Occasionally the product is sufficiently pure to subject it directly to the various tests for morphine, but in the great majority of cases it is necessary to remove still further any extraneous matter that may be present by washing the material once or twice with a few drops of ice-cold water and afterward with a little absolute ether. The residue from these operations should then be submitted to the four tests for morphine previously described. If the material examined is crystalline, and each one of the four tests mentioned gives unequivocal results, the presence of morphine is demonstrated.

Fig. 80.—Crystals of Morphine from Stomach, crystallized from amyl alcohol. Magnified 18 diameters. (Drawn with the *camera lucida* by Dr. E. R. Le Count.)

It is of the utmost importance in examining for morphine that the residue to be tested should be thoroughly purified and freed to the greatest extent possible from all foreign material. None of the tests for the alkaloid are absolutely conclusive when acting upon unknown complex mixtures. Professor Vaughan has clearly shown that under certain conditions normal constituents of the gastro-intestinal tract may give reactions strikingly similar to those produced by morphine when not thoroughly purified, and I have myself on two or three occasions extracted from the stomachs of persons who died from other poisons, compounds which behaved remarkably like morphine, and which could be distinguished from the latter only after the most rigid purification. I should be unwilling to accept the presence of morphine as having been demonstrated unless the alkaloid had been isolated in a pure or practically pure crystalline form, and had given with all four tests before described unequivocal reactions.

If, in a suspected case, morphine alone is believed to have been given, the above process may be materially shortened by omitting that part which relates to the determination of meconic acid; the precipitation by lead acetate, and the subsequent filtration and treatment of the filtrate with hydrogen sulphide, may be dispensed with, and the liquid may be operated on at once for the extraction of morphine as above.

In the Tissues.—As a rule meconic acid and morphine are not detected in the tissues of the body even after considerable doses have been taken, but in case the examination is to be made we may proceed as follows: A part or the whole of the organ, such as the liver, kidney, or brain, is to be very finely subdivided, mixed with water to a thin paste, and heated gently for two or three hours after having been rather strongly acidulated with tartaric or some other equally active acid. The mixture is then strained and gently evaporated to a moderate bulk, when three or four times its volume of strong alcohol should be slowly stirred in, and the liquid filtered from the insoluble precipitate produced; the filtrate is concentrated on the water-bath until all alcohol has been expelled and a syrupy residue is obtained; this is extracted with water, filtered, and the filtrate treated with ammonia and hot amylic alcohol as before described. The alcohol is evaporated on a watch-glass, and the residue may be purified and tested as given above in connection with the examination of the *contents of the stomach.*

Failure to Detect.—Opium and morphine both resist decomposition in a marked degree, so that there is a possibility of detecting their presence even a considerable time after death. Allen obtained satisfactory proof of the presence of meconic acid in the stomachs of two children exhumed five months after death, and Taylor has detected both meconic acid and morphine in mixtures which had undergone decomposition for a period of fourteen months. On the other hand, however, there is not infrequent failure to detect any trace of the poison even when the examination is promptly made. Of all the ordinarily used poisons, none is more likely to escape discovery than opium and morphine. Why this is we do not fully know, but several causes probably conspire to produce this result: (1) Death does not usually occur until the end of a number of hours, and a chance is afforded for the complete absorption of the poison from the stomach, and its entire or partial elimination from the rest of the body; (2) our tests for meconic acid and morphine when in complex or organic mixtures are not extremely delicate; and (3) it appears quite likely that under some conditions opium and morphine undergo chemical change in the body even before death takes place.

Surgeon-Major Ross reports that there were forty-five fatal cases of opium poisoning in the Bengal Presidency in 1869, and that an analysis was made in each case, yet in only two was opium detected in the stomachs. This is an extreme case, and may be accounted for, partially at least, by the fact that the means for detecting opium twenty-five years ago were not nearly as delicate as those used to-day. Still, a considerable number of cases in late years have been recorded of known death from opium in which the poison was not afterward discovered in the stomach. I have myself had at least one such experience, having failed to find the slightest trace of morphine in the stomach of a woman who was known to have taken not less than ten or fifteen grains of the drug for suicidal purpose. She lived for about eighteen hours after swallowing the poison; the stomach was removed soon after death and was promptly examined, but not the faintest reaction for morphine was obtained after repeated and most careful tests.

NOTE.—As opium and morphine are extensively used as remedial agents, and are not infrequently taken for the relief of pain without the advice of a physician, and, moreover, as these substances are present in

a considerable number of patent medicines which are in common use, the detection of morphine or meconic acid in a body after death would by no means necessarily indicate that poisoning had occurred.

NUX VOMICA AND STRYCHNINE.

Nux vomica, the seed of *Strychnos Nux-vomica*, owes its poisonous properties chiefly to the presence of strychnine (synonyms, strychnin and strychnia). It contains, however, another alkaloid, brucine, which is analogous in its physiological properties to strychnine, but is so much feebler that it adds comparatively little to the toxic powers of the drug. Strychnine exists in nux vomica, combined with lactic and igasuric acids, in the proportion of from 0.5 percent. to upward of 1.5 percent. Strychnine is also found in the seeds of *Strychnos Ignatii*, and in three or four other species of strychnos.

Chemical Properties of Strychnine.—Strychnine appears in commerce either as a white powder made up of minute crystals, or in the form of larger crystals, which are sometimes octahedral and sometimes prismatic.

It is very sparingly soluble in water, requiring 8333 parts of that fluid to dissolve it when cold, but it is somewhat more soluble in hot water. It dissolves in a little more than 200 parts of alcohol at ordinary temperature, and in about 400 parts of whiskey and other similar spirituous liquors; it requires 1400 parts of pure ether to effect its solution, but it dissolves readily in 8 or 10 parts of chloroform; it also dissolves readily in a mixture of equal volumes of ether and chloroform.

The alkaloid is of alkaline reaction, and when brought in contact with acids neutralizes them, producing salts most of which are quite readily soluble in water and alcohol. The salt most commonly used in medicine is the sulphate, which occurs in commerce in the form of colorless or white prismatic crystals, soluble in 50 parts of water and about 100 parts of alcohol.

An interesting and important point in connection with the properties of strychnine is its resistance to the destructive effects of sulphuric acid even when heated on the water-bath. Most organic compounds when treated with sulphuric acid, especially when they are heated with it, are chemically changed and lose their identity; the difference in the behavior of strychnine in this respect affords a valuable means of separating it from other substances, and of completely purifying it during the process of extraction from the stomach or other organs of the body.

Strychnine is intensely bitter, this property being so strongly marked that one part of it gives a decided taste to 70,000 parts of water; its bitterness, moreover, is very persistent, clinging tenaciously to the tongue and fauces, and being removed with difficulty. It is an important fact, however, that some persons are unable to recognize the bitterness of strychnine, and I have personally met four illustrations of this. They were all men in good health, and they knew that beer, quassia, and many other substances are bitter, but they could not recognize the bitterness of strychnine; they described it as having a rough or slightly musty taste. All of the men in question used tobacco, and one of them drank liquor somewhat to excess; one also had some nasal catarrh, but not to

such a degree as to interfere materially with the appreciation of ordinary odors and tastes.

The fact that strychnine is not necessarily bitter to all people is occasionally of medico-legal importance in such cases as the following: A person after partaking of food is suddenly seized with violent convulsions and soon dies. In spite of the fact that strychnine is found in the body by analysis, yet as the person made no complaint that the food eaten was bitter, although abundant opportunity was afforded for doing so, doubt is entertained as to the cause of death, and, in case of legal inquiry, this circumstance is made a strong point by the defense. It is quite possible, however, in such cases that the deceased, like the persons mentioned above, was either wholly or largely incapable of recognizing the bitterness of strychnine.

The taste of strychnine, moreover, may be considerably masked, and its bitterness largely concealed, by the presence of certain other substances, such as tannic acid, licorice, and chocolate. In a case of poisoning which came under my observation not long since, it was claimed by the defense at the time of trial that strychnine could not have been administered, as the deceased had complained of bitterness but slightly after eating some confectionery which the prosecution alleged contained the poison. Since the candy, however, was composed largely of chocolate, the absence of intense bitterness was easily explained.

Symptoms.—Both nux vomica and strychnine produce essentially the same effects, the only difference observable being that the latter, as would naturally be expected, acts somewhat more rapidly than the former.

The symptoms occasionally begin to show themselves immediately after the swallowing of the poison, but more often they are delayed for ten or fifteen minutes; they do not usually appear earlier than five minutes, nor are they often delayed later than an hour, although they have been known to be postponed until the end of the third hour. This great difference in time of the first symptoms is due chiefly to the form in which it is administered and to the condition of the stomach. If taken in solution it acts more rapidly than in the form of a powder, and in pills it is still slower in its action; if taken on an empty stomach it is absorbed more quickly and produces its effects earlier than when the stomach is full of food.

The first symptom manifested is usually a sense of discomfort, accompanied by a feeling of tightness about the chest and throat, and a twitching of the muscles of the hands and feet. These, however, usually last but a short time, and are followed suddenly by a violent tetanic convulsion; sometimes the entire muscular system seems to be affected almost simultaneously, but generally the rigidity appears first in the extremities, rapidly extending to the trunk, and finally to the face and jaws. The legs are extended, the feet arched, and the head is thrown violently backward, so that the body often rests only upon the heels and occiput, producing a condition known as opisthotonos; the arms are sometimes widely extended and sometimes drawn tightly across the chest; the muscles of respiration become so rigid that breathing is difficult and often seems to cease, and the pulse is weak and irregular, occasionally becoming imperceptible. The countenance is livid, the eyes staring, the pupils widely dilated; foam often appears at the mouth, and

the countenance generally assumes a ghastly, grinning expression. The convulsion lasts from half a minute to several minutes, when the muscular rigidity nearly or entirely disappears. There is generally now a condition of great relaxation: cold perspiration breaks out over the whole body, the pupils contract, a sense of weariness is expressed, and the patient not infrequently sinks into a profound sleep. This period of intermission continues from a few minutes to half an hour, when another paroxysm shows itself. It sometimes comes on unexpectedly, but often is preceded by a few moments of intense anxiety on the part of the patient, who piteously pleads for relief. All the senses are unnaturally excited, and the convulsion is often brought on by a loud noise, the slamming of a door, a sudden current of air, or even a gentle touch. The second paroxysm is usually a counterpart of the first, but is more severe; the breathing is more difficult, the strength more exhausted, and the suffering more acute. After two or more paroxysms, unless relief is afforded, the patient dies, either in the height of a convulsion from asphyxia, or at the close of one from exhaustion. The mind is usually not affected, the intellect generally remaining clear until the end, and there is a thorough appreciation of the gravity of the situation and the imminence of death. Vomiting is occasionally but not often seen.

However given, strychnine produces essentially the same effects, and numerous cases are recorded of violent symptoms from its hypodermic use; it is usually more active when thus administered than when taken by the mouth, one sixteenth of a grain having occasioned alarming symptoms.

When associated with other drugs, as would naturally be expected, the effects of strychnine may be materially masked; opium, morphine, chloral, and other narcotics greatly retard its action and modify its symptoms.

Diagnosis of Strychnine Poisoning.—The manifestations produced by a poisonous dose of strychnine are so characteristic that usually there is but little difficulty in making an accurate diagnosis from the symptoms alone. On various medico-legal occasions, however, it has been claimed that several diseases might be mistaken for strychnine poisoning, among others being epilepsy, uræmic and puerpural convulsions, chorea, the various forms of tetanus, and even syphilis. But all of these, with the exception possibly of tetanus, differ so essentially in their manifestations from strychnine poisoning, that they could not possibly be confounded by a competent observer. The different forms of tetanus do in some respects resemble strychnine poisoning, yet there are such well-marked differences between them that after careful examination they should never be mistaken for each other. In both, it is true, there are violent tonic spasms which are strikingly similar, but in almost all other respects they are unlike.

In tetanus we almost always have a history of an injury, and the disease usually comes on gradually and progresses slowly to a fatal termination, a number of days generally elapsing between the onset of the disease and death, while in strychnine poisoning there is no antecedent injury, and the manifestations appear suddenly, almost without warning, and progress rapidly to a fatal termination; in tetanus the muscles first affected are generally those of the back of the neck, and those of the jaw are early invaded, producing persistent lockjaw, while in strychnine

poisoning either the muscles of the extremities are first affected, and those of the neck and jaw last attacked, or the entire muscular system is thrown into a spasm almost, or quite, simultaneously; in tetanus there is usually considerable persistence of the muscular rigidity even between the severe spasms, and opisthotonos, or some other perverted position of the body, is generally permanent, while in strychnine poisoning there is almost always complete relaxation between the spasms, and the opisthotonos, which may have been very marked during the attack, entirely passes away; in tetanus the temperature is generally somewhat elevated beyond the normal, while in strychnine poisoning it is not usually affected.

There are, it is true, occasionally marked exceptions to the above differences, one case being recorded in which tetanus proved fatal in twelve hours after the first twitchings, another within an hour and a half after the first convulsion, and a third in fifteen minutes after the injury producing the disease; on the other hand, a case of strychnine poisoning is recorded in which death occurred after a lapse of eighteen hours, and several cases are known in which repeated small doses of the poison have been administered in such a way as to extend the symptoms over a period of several days. So also in tetanus, cases are occasionally seen in which little or no increase of temperature is found, while in poisoning by strychnine the temperature is sometimes elevated. In spite, however, of these irregularities both in strychnine poisoning and in tetanus, a competent observer will rarely have difficulty in distinguishing the two, the difference in the order in which the muscles are attacked and the marked dissimilarity in the condition of the patient between the spasms generally sufficing to establish the exact character of the derangement.

Period when Fatal.—One or two cases are recorded in which death is said to have occurred almost immediately after the ingestion of the poison, and two or three are on record in which the fatal termination came in ten minutes. In most cases strychnine acts rapidly, and death almost always occurs within two hours; if the person lives beyond this time his chance of recovery is good. Some cases, however, are much prolonged; at least four are recorded in which death was delayed for six hours, and Tardieu and Roussin have reported a protracted case in which death did not occur until the eighteenth hour. In a case of strychnine poisoning which I was called on to investigate two years since, death occurred in eleven hours after the administration of the poison; morphine and chloroform, however, had been abundantly administered, and this probably accounted for the long delay.

Fatal Quantity.—A quarter of a grain is recorded as having occasioned death, and good authorities believe that even one sixth of a grain should be regarded as a possibly fatal dose. Dr. Warner, who took by mistake not over half a grain of the sulphate of strychnine, died from its effects in eighteen minutes.

But numerous cases are reported of recovery from large doses, such as fifteen, twenty, and even forty grains; in almost all of these, however, there was early vomiting, or the stomach was promptly evacuated by emetics or by the stomach-pump, and energetic general treatment was employed.

Treatment.—The stomach should be at once evacuated by the use of emetics or the stomach-pump; owing, however, to the violent spasms

which early set in, it is often difficult or impossible to use the stomach-pump until by the plentiful administration of chloroform the tetanic condition is relieved, when the tube may be inserted with ease. Tannic acid, solution of iodine, or finely pulverized charcoal may be administered as supplements to the use of emetics or the pump; they render the strychnine less soluble and retard its action. Chloroform should be freely given by inhalation during the paroxysms, and chloral may be administered with great advantage in the intervals, either by the mouth or hypodermically. During the convulsions, when there seems impending death by asphyxia, pure oxygen may be played over the mouth and nose, and it sometimes affords marked relief.

The patient should be kept as quiet as possible; all strangers should be excluded from the room, direct draughts of air should be shut off, and loud noises, such as those produced by the slamming of doors, stamping of feet, etc., should be prevented. For the same reason, as little medicine as possible should be given internally, as the mere raising of the head, or the touching of the lips with a spoon may cause a convulsion. Experiments on animals have repeatedly shown that absolute quiet is a very important factor in securing recovery from poisonous doses of strychnine; and clinical experience abundantly demonstrates that the same is true with man.

Post-mortem Appearances.—The stomach is usually normal, but is sometimes found in a state of intense congestion; the liver, kidneys, and lungs are frequently engorged with blood; the heart is occasionally full and distended, but rather more often is empty and flaccid. The brain and spinal cord and their surrounding membranes are occasionally normal in appearance, but usually are congested, and sometimes present effusions of serum or blood. The muscles immediately after death are usually relaxed, but rapidly take on extreme rigidity, which is generally very marked; neither arms nor legs can be bent except with great difficulty, and the body often lies in a condition of opisthotonos. The rigidity occasionally disappears within a few hours, but sometimes lasts for weeks, and even months. In a case of death from strychnine which I examined some time ago, I found the body five months after death intensely rigid, though decomposition had progressed to a marked degree.

None of the above post-mortem appearances are entirely characteristic of death by strychnine, although the congestion of the brain and spinal cord, the effusions of blood and serum about them, and the well-marked rigor mortis are rarely produced collectively by any other cause.

Tests.—Strychnine responds to all the general reactions for alkaloids, giving precipitates with tannic acid, picric acid, iodine, etc., but these are not particularly distinctive. Fortunately, however, we possess several tests that are highly characteristic, of which four are particularly valuable, namely: the taste, the color test, the chromate test, and the physiological test.

(*a*) *The Taste.*—As has already been stated, strychnine is intensely bitter, and it has this property in a higher degree than any other known substance. In examining a suspected residue, therefore, we expect to find more or less bitterness if the alkaloid is present. Many other substances, however, as is well known, are also bitter, such as quinine, salicine, and morphine, but none of these approaches strychnine in the intensity of its bitterness.

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By a careful comparison of the two substances when tested side by side, a slight difference can be seen in the intensity and duration of the colors; but if the strychnine is somewhat impure, as is likely to be the case upon extracting it from a part of the body, the two reactions are practically indistinguishable. Quebrachine, however, is destroyed by heating it on the water-bath with strong sulphuric acid, while strychnine is not, and by this process we may separate the two absolutely. Aspidospermine (another alkaloid of quebracho bark) as it appears in the market sometimes contains so much quebrachine as to give it a well-marked strychnine-like reaction.

In a few rare cases ptomaïnes have been found which gave a color reaction somewhat similar to that of strychnine; but as they differed from strychnine in other properties, and as, without doubt, they would be destroyed by heating with sulphuric acid, there would be no possibility of confounding the two if proper skill were employed in making the tests.

The color reaction for strychnine is more or less interfered with by the presence of a number of other substances, such as morphine, brucine, and nitrates; of these the most important is morphine, which has the power in a marked degree of preventing the color reaction if present in moderate amount. I have known of at least one case in which the presence of strychnine in the organs of a body was entirely overlooked on account of its association with a considerable quantity of morphine, and the use of inadequate means of separating the two in the analytical process employed. When the two alkaloids are present in a mixture they may be separated by a number of means, but heating with strong sulphuric acid is generally the best; it removes the morphine and enables the strychnine to be recognized readily. Practically, the most common substance interfering with the color test in toxicological examinations are certain indefinite organic compounds derived from the organs examined, which are almost sure to be extracted to a greater or less degree with the strychnine. The presence of even a moderate amount of this material sometimes wholly prevents the recognition of the alkaloid by this test. By careful purification, however, it may be removed, when the color reaction comes out distinctly.

Fig. 81.—Crystals of strychnine chromate. Magnified 90 diameters. (Drawn with the *camera lucida* by Dr. E. R. Le Count.)

(*c*) *Chromate Test.*—If an aqueous solution of a salt of strychnine is treated with a solution of potassium bichromate, a yellow precipitate of strychnine chromate is produced, unless the solutions are too dilute. The precipitate, if examined under a microscope, is found to consist of a mixture of octahe-

dral and dendroidal crystals, which are very characteristic. If the crystals are allowed to settle, the supernatant fluid drained off, and the precipitate well dried, upon touching them with a drop of strong sulphuric acid a fine play of colors is at once produced, exactly the same as those described under the color test. This double reaction for strychnine is probably the best we possess for the alkaloid, as it combines the characteristic play of colors of the oxidation test with the peculiar crystals of the chromate of strychnine. No other known substance produces the same effects.

(*d*) *Physiological Test.*—If strychnine is administered to a frog the animal is soon thrown into convulsions, and if the dose is sufficiently large, death ensues. Advantage may be taken of this fact in testing an unknown substance for the presence of the alkaloid. The material should be dissolved in a little dilute acid and given to a small frog, either by hypodermic injection or by blowing it into the animal's stomach through a small tube. The frog should then be covered with a bell-jar and carefully watched; if strychnine is present, in the course of a few minutes the animal becomes vigorously tetanized; its head and trunk become rigid, and its hind legs are violently extended. The paroxysms at first have remissions, during which the animal assumes its normal posture, but by blowing across it, by striking the table, or by otherwise slightly disturbing the animal, it is again thrown into a violent convulsion, and if these are kept up sufficiently long death follows. This test, if applied to a very small animal, is fairly delicate, the 1–10,000 of a grain usually being recognizable by it. It is also quite characteristic, for while some other substances occasion convulsions in frogs, they differ materially from those produced by strychnine in lacking the intense tetanic character of the latter. The test, therefore, is a good one, and should be applied when it is practicable, but I do not agree with some authors who insist that without it the presence of strychnine has not been definitely established; it is absolutely certain that in competent hands the chemical tests for strychnine are more delicate than and fully as reliable as the physiological test.

Fig. 82.—Crystals of strychnine from stomach, crystallized from chloroform. Magnified 12 diameters. (Drawn with the *camera lucida* by Dr. E. R. Le Count.)

Detection of the Poison.—*In the Contents of the Stomach.*—The material should be finely comminuted if necessary, mixed with enough water to make it thoroughly fluid, strongly acidulated with acetic acid, and digested on the water-bath for about an hour, replacing from time to time the liquid that may evaporate with a little water. The hot mixture should be strained, the liquid evaporated on the water-bath to about

a quarter of its original bulk, and while still hot five or six times its volume of strong alcohol slowly stirred in. This causes the separation of a considerable amount of insoluble material, which should be removed by filtration. The filtrate is evaporated to a syrupy consistence on the water-bath, and when cold is taken up with a small amount of water slightly acidulated with acetic acid; the mixture is filtered into a strong flask, test-tube, or separatory bulb, a very slight excess of potassium hydrate added, an equal bulk of chloroform at once poured in, and the mixture vigorously shaken. When the chloroform has settled out the aqueous fluid is removed and again shaken with another volume of chloroform; the two chloroform solutions thus obtained are united and allowed to evaporate at a gentle heat in a porcelain dish. The residue, which contains practically all of the strychnine present in the stomach, is usually too much contaminated with extraneous substances for direct testing for the alkaloid, and should be further purified; this may be at least partially accomplished by stirring it up with dilute acetic acid, filtering, rendering alkaline, and shaking with chloroform as before. Upon evaporating the chloroform the strychnine will occasionally be deposited in a crystalline and nearly pure condition, but more often there is still enough impurity present to interfere somewhat with the unequivocal recognition of the poison, and as a rule it is much safer, before applying tests, to purify the residue still further. For this purpose it is treated with two or three drops of strong sulphuric acid, and heated on the water-bath for an hour or two. During this process the strychnine is but slightly changed, while most or all of the accompanying impurities are carbonized or are otherwise chemically altered and lose their identity. The mixture is diluted with water, filtered, alkalinized, shaken out with chloroform, and the latter allowed to evaporate in a watch-glass. The residue is now almost always sufficiently pure to be tested for the presence of the alkaloid. It should first be examined under a low power of the microscope for the presence of crystals, which will usually be found in case the amount of strychnine is more than a trace. The residue may then be dissolved in a little dilute acetic acid: one drop of this is put upon the tongue, and the taste carefully observed; another is evaporated on a small porcelain plate, and the residue treated with sulphuric acid and an oxidizing agent for the color reaction; to a third drop a solution of potassium bichromate is added, and any precipitate obtained is carefully examined under the microscope, and subsequently dried and treated with

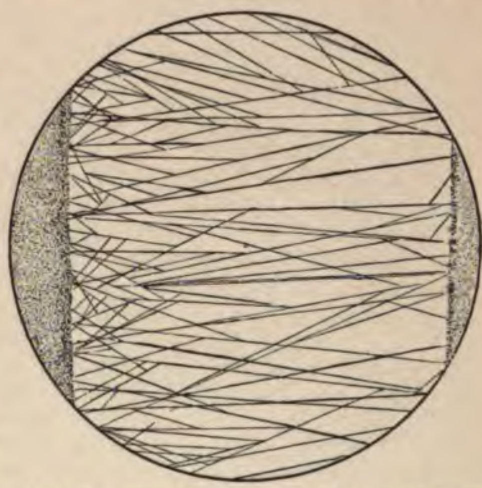

Fig. 83.—Strychnine from stomach, crystallized from chloroform, showing different crystalline forms from those in Fig. 82, p. 456. Magnified 40 diameters. (Drawn with the *camera lucida* by Dr. E. R. Le Count.)

sulphuric acid as before described; and finally a few drops are administered to a small frog, and the effects critically observed. If the results of all these tests agree with those obtained from strychnine, the presence of the poison is established.

It is very desirable in testing an unknown residue for strychnine, or for any other poison, to have a small amount of the substance for which we are examining at hand, and to apply the same tests side by side to the suspected and to the known material. If we obtain identical reactions with all our tests, the evidence of the presence of the poison is conclusive, but not otherwise.

Upon shaking the alkaline fluid with chloroform as directed above, it not infrequently happens that an emulsion is formed, from which the chloroform separates very slowly and imperfectly; to obviate this a mixture of equal parts of chloroform and ether may advantageously be used, as has already been spoken of on page 420.

The use of strong sulphuric acid for purifying strychnine, as described above, is strongly recommended; it removes very efficiently a large number of other substances, some of which may seriously interfere with the tests for the alkaloid, and it very materially adds, therefore, to the certainty of detecting the poison. The sulphuric acid used, however, must be entirely free from nitrous compounds, since the latter when heated with strychnine destroy it.

In the Tissues.—If the person lives sufficiently long after a fairly large dose of strychnine, the alkaloid may generally be found in nearly all parts of the body; the organs, however, in which it is usually most easily detected are the liver and the kidneys, and it may often be discovered in the spleen, heart, brain, and blood. To separate it from these, the tissue is to be very finely subdivided and digested for an hour at a gentle heat with dilute alcohol strongly acidulated with acetic or tartaric acid. The mixture is then filtered, the residue repeatedly washed with acidulated alcohol, and the mixed filtrates evaporated almost to dryness. The residue is taken up with a little water, filtered, alkalinized, and shaken with chloroform. The chloroform is evaporated, and the residue purified and tested as directed above in connection with the contents of the stomach.

Quantitative Determination.—It sometimes is of great importance to determine the amount of strychnine present in the contents of the stomach or in the tissues, for as nux vomica and strychnine are extensively used in medicines, the finding of a mere trace or even a remedial dose of the alkaloid in the body would not necessarily point to poison as the cause of death. Whenever, therefore, strychnine, or any preparation containing it, is known to have been taken for medicinal purposes before death, a most rigorous quantitative determination of the poison should be made. For this purpose the method described above may be followed as far as allowing the chloroform, after the carbonizing process, to evaporate in a watch-glass. The residue thus obtained, although it may be sufficiently pure for qualitative tests, is not fit for weighing, as it still is liable to contain more or less impurity. It should be washed, therefore, with a few drops of ice-cold water, dried, again carbonized with strong sulphuric acid, and again extracted with chloroform as before. The latter should be allowed to evaporate in a tared watch-glass, and the residue obtained should once more be washed with one or two drops of ice-cold

water, carefully dried on the water-bath, and when cold, weighed. This process is somewhat long, and in carrying it out some strychnine is always lost, but it yields, when properly executed, a very pure product, which may be weighed with great assurance as being the alkaloid nearly, if not quite, free from impurities.

In several cases of strychnine poisoning the accused at the time of trial has presented the defense that the strychnine found in the body came from homeopathic preparations of nux vomica which the deceased had been using. Such a plea, however, is rarely or never valid in case a ponderable amount of pure strychnine was found in the remains, for the quantity of the alkaloid in the ordinarily used homeopathic preparations is very minute; I have found that a grain of the third decimal trituration of nux vomica, as obtained from a reliable homeopathic pharmacy, when mixed with the contents of a stomach afforded absolutely no definite qualitative test for the presence of strychnine, and consequently was very far from giving a quantitative result.

Detection after Long Periods.—Strychnine resists decomposition to a very marked degree, and it may be detected, therefore, in a body even a considerable period after death. Professor Wood reports finding the poison a year after death, and I also on one occasion extracted it in ponderable quantity from a body that had been buried nearly twelve months. Allen states that he detected strychnine in a stomach which had been kept untreated in a jar for six years; Richter was able to extract it from putrid tissues exposed for eleven years; and Woodman and Tidy report finding it in a dog's stomach after it had been sealed up in a bottle for thirteen years. Experiments on animals seem to indicate, however, that the alkaloid slowly disappears when the body is buried underground, so that the amount that can be extracted progressively diminishes, and finally the poison can be no longer recognized.

Failure to Detect.—It has occasionally happened that no strychnine has been found in the body after death even when it was known to have been taken. Probably the larger number of these failures to detect have been due to imperfect methods of extraction, or to incompetent manipulation; still, a few cases are on record in which expert investigators have been unable to find the poison though it was known to have been used. Such a case is reported by Dr. Reese, and Professor Sonnenschein reports another case in which he could not discover the poison in either the tissues or the blood, although he detected it in the stomach. A few months since I was called on to examine the stomachs of two children who died suddenly with all the symptoms of strychnine poisoning; no other cause of death was found or could be suspected, yet most careful examinations failed to show the presence of the slightest trace of the poison in either organ. Upon adding a tenth of a grain of the alkaloid to a reserved portion of the stomachs it was easily detected, showing that the method used was reliable, and that no interfering substance was present. In both of these cases the amount of strychnine taken was probably the minimum fatal dose, and as the stomachs were not presented for analysis until more than a month after death, it is barely possible that the poison may have undergone decomposition.

Elimination.—Strychnine is eliminated from the body chiefly by the kidneys, and its presence in the urine may usually readily be demonstrated even when fairly small doses have been taken. The examination

of the urine for strychnine is sometimes of great importance in cases of suspected poisoning, as a means of verifying the presence of the poison in the system. The elimination by the kidneys is rapid, no strychnine being found in the urine generally after the second day. The poison, therefore, seems to be eliminated from the body within forty-eight hours.

BRUCINE.

Brucine (synonyms, brucin and brucia) is found in various strychnos plants associated with strychnine. Both alkaloids have similar physical and chemical properties, and produce almost identical physiological effects. Brucine, however, is much feebler in its toxic powers than strychnine, being estimated as having only from one seventh to one thirty-eighth of the latter's activity. The cause of this wide difference of opinion as to its powers is probably due to the fact that some of the experimenters have operated with specimens of the alkaloid that were more or less impure; still, it is safe to say that brucine does not have more than one fifteenth the activity of strychnine. In its physiological action it is identical with the latter in the character of its effects, differing only in intensity. All that has been said, therefore, concerning the symptoms of strychnine poisoning may be repeated in regard to brucine, provided a sufficient dose of the latter is taken. The same treatment should be pursued, and the same post-mortem appearances are observed. The poison may be extracted from the contents of the stomach and from the tissues in a manner similar to that described under strychnine; but the tests by which we identify it are different. Like strychnine, brucine is intensely bitter, and when administered to a frog it also occasions tetanic convulsions, but the quantity necessary to produce this effect is much larger than with strychnine. Unlike strychnine, however, when treated with sulphuric acid and an oxidizing agent brucine does not produce the characteristic play of colors occasioned by the former, and in this way the two alkaloids may be easily distinguished.

The best and most characteristic test for brucine is the combined use of nitric acid and stannous chloride. If the alkaloid is treated with nitric acid a blood-red color is produced, which is very intense, even though the amount of brucine present be small; upon gently warming the color fades to orange and yellow, and after cooling, if a solution of stannous chloride is added a fine purple color is developed. This reaction distinguishes it not only from strychnine, but from all other alkaloids. Nitric acid, it is true, strikes a red color with morphine and with several other substances, but with none of these is there a change to purple upon the subsequent addition of the tin salt.

VERATRUM, VERATRINE, AND JERVINE.

The various veratrums are characterized by the presence of a number of alkaloids, most important of which are veratrine and jervine. The chief veratrums in medicine and toxicology are *Veratrum album*, or white hellebore, and *Veratrum viride*, or American hellebore, in both of which veratrine and jervine are found associated with three or four other alkaloids.

Both the white and the green veratrums and their two chief alkaloids have similar toxic powers, and all may be considered together.

Properties of the Alkaloids.—Both veratrine and jervine when pure are colorless, odorless solids, which may be obtained in a crystalline form with ease in the case of jervine, and with difficulty in the case of veratrine. They have an exceedingly acrid, bitter taste, and veratrine is excessively irritating when applied locally to the skin; if inhaled into the nostrils, even in very minute quantities, it produces violent sneezing. Both are very sparingly soluble in water, but both dissolve with readiness in chloroform; veratrine dissolves in ether without difficulty, while jervine is but slightly soluble in it. Both alkaloids possess well-marked basic properties, uniting with acids and producing salts.

Symptoms.—After the ingestion of a poisonous dose of either veratrum album or veratrum viride, or their alkaloids, the effects generally shown are severe burning and pain in the stomach and bowels, intense nausea, violent vomiting, painful purging, great prostration, cold extremities, small and feeble pulse, vertigo, blindness, and sometimes convulsions and coma.

These symptoms are by no means invariable; in some cases the effects upon the brain predominate, while in others the cerebrum appears to be but little involved. Intense nausea, vomiting, and purging are generally present, yet occasionally they are nearly or quite absent.

Period when Fatal.—Just as with colchicum, the active principle of which was formerly confounded with veratrine, the two veratrums generally lead to a fatal result only after a lapse of considerable time. A case is reported in which death occurred from veratrum album in three hours, and another in six hours from veratrum viride, but as a rule a fatal termination is not reached short of a considerably longer period than these, and one case is on record in which death did not occur until four weeks after taking the fatal dose.

Fatal Dose.—Twenty grains of veratrum album in the form of a powder, and half a dram of the tincture of veratrum viride, have proved fatal; but on the other hand, very large doses have been recovered from. Dr. H. C. Wood states that he has several times known a teaspoonful of the fluid extract of veratrum viride to be taken without producing death, and recovery has occurred after the ingestion of a tumblerful of the tincture of the same drug. Dr. Blake, of St. George's Hospital, reports the recovery of a patient after swallowing a liniment supposed to contain three grains of veratrine.

Treatment.—Vomiting, if present, should be encouraged by the copious administration of tepid water; if emesis does not occur spontaneously, an emetic should be given or the stomach-pump used. The patient should be kept flat upon his back, the head lower than the feet, and after the stomach has been thoroughly evacuated an opiate should be given to control the pain and quiet the vomiting. The prostration should be combated by stimulants such as external heat, alcohol, and ammonia, and inhalations of amyl nitrite have been recommended.

Post-mortem Appearances.—The gastro-intestinal tract is usually found in a state of congestion, although this is sometimes entirely wanting, and the lungs, liver, and other viscera are usually engorged with blood; the post-mortem appearances, however, as in most other cases of poisoning with alkaloids, are neither constant nor characteristic.

Tests.—Both veratrine and jervine respond to the general tests for alkaloids, giving precipitates with tannic acid, iodine, etc. The special reactions which characterize them are as follows:

1. **Veratrine.**—(*a*) *Sulphuric Acid Test.*—If veratrine is treated with strong sulphuric acid it dissolves to a yellow solution, which upon standing changes to a brilliant red, the latter color persisting unchanged for many hours. (*See Pl. VIII., No. 6.*) If after applying the sulphuric acid the mixture is heated, the deep red color is developed at once, and upon further application of heat it remains unchanged for a long time.

This is an exceedingly delicate test for veratrine, and when properly observed a very characteristic one. Several other substances, it is true, when treated with strong sulphuric acid produce colored mixtures, some of which, like that obtained with veratrine, are dark red; but they may be distinguished from the latter alkaloid either by the fact that their red color is developed immediately upon the application of the acid, or else that upon heating the color is changed quite differently from that produced by veratrine. Salicine, for instance, is colored deep red by contact with strong sulphuric acid, but the color is developed at once, and upon moderate heating it turns brown and finally almost black.

(*b*) *Hydrochloric Acid Test.*—Strong hydrochloric acid dissolves veratrine without change of color, but if the solution is boiled for some time it assumes an intense red color. This reaction, like the preceding one, is very delicate, and is even more characteristic, for no other alkaloid, according to Dragendorff, gives a similar reaction. It should be stated, however, that ptomaïnes have been extracted from dead bodies which gave reactions strikingly similar to those produced by veratrine both with this test and with the preceding one.

(*c*) *Physiological Test.*—If a small quantity of veratrine is administered to a frog hypodermically, it produces characteristic effects. Very soon after the administration the animal vomits, and the pulsations of the heart rapidly diminish to ten or fifteen a minute; at the same time peculiar spasmodic contractions of the muscles set in, which sometimes resemble the tetanic convulsions produced by strychnia; and finally, if the dose of the alkaloid is sufficiently large, the animal dies.

2. **Jervine.**—The most characteristic test for jervine is based upon the fact that its salts with sulphuric, hydrochloric, and nitric acids are sparingly soluble in pure water, and are still more insoluble in the presence of an excess of the acid. If, therefore, to a fairly strong solution of the alkaloid in acetic acid a slight excess of one of the mineral acids before named is added, the jervine is precipitated in the form of a difficultly soluble and highly crystalline salt.

Detection of the Poison.—*In the Contents of the Stomach.*—The examination should be conducted as described on page 418 for the general extraction of alkaloids. The first chloroform residue, if mixed with much foreign matter, should be purified by re-solution in dilute acetic acid, filtration, alkalinization, and reëxtraction with chloroform; the residue from this is generally fit for the application of the various tests for veratrine or jervine.

The physiological test for veratrine should not be omitted, since, as we have seen before, ptomaïnes have been found which gave chemical reactions much like those produced by veratrine, but they have not given the characteristic physiological effects of the alkaloid.

In the Tissues.—The parts should be finely subdivided, mixed with dilute alcohol strongly acidulated with acetic acid, gently heated on the water-bath for some time, the mixture strained, and the subsequent examination conducted exactly as with the contents of the stomach.

2. Organic Poisons not Alkaloids.

DIGITALIS.

All parts of the plant commonly called foxglove, and known botanically as *Digitalis purpurea*, are possessed of marked physiological activity. The leaves are the portion commonly used in medicine, and they are the part that is official in the United States Pharmacopœia under the name of digitalis.

The drug contains a number of active principles, of which the most important are *digitalin*, *digitonin*, *digitoxin*, and *digitalein*.

These substances differ decidedly in many respects from the active principles we have been considering, such as strychnine, morphine, etc.; unlike the latter, they do not contain nitrogen, and are not possessed of basic properties, and are therefore not alkaloids. Upon being treated with dilute sulphuric or hydrochloric acid they are decomposed, one of the products of decomposition (except in the case of digitoxin) being glucose; hence they belong to the class of substances known as glucosides. Digitoxin is converted by boiling with dilute acids into an amorphous body, *toxiresin*, and is not, therefore, a glucoside.

Of the four active principles above mentioned, digitalin and digitoxin are the most important, and it is to them that digitalis chiefly owes its remedial virtues and poisonous properties. Both bodies when pure appear in the form of colorless crystals of neutral reaction and possessed of an intensely bitter taste. They are very sparingly soluble in water, in benzine, and in ether, but dissolve without difficulty in chloroform and alcohol. The substance known in commerce and pharmacy as "digitalin" varies greatly in composition according to the method of its manufacture, but it is usually composed of variable mixtures of digitoxin and true digitalin.

Symptoms.—Digitalis when taken in toxic doses develops two chief series of symptoms: those referable to the heart, whose action is remarkably retarded and enfeebled, and those connected with the gastro-intestinal tract, upon which the drug acts much like one of the irritant poisons, producing violent vomiting and persistent purging. Sometimes the cardiac symptoms are most prominent and at other times those of the gastro-intestinal tract are the most conspicuous, but the usual manifestations are as follows: Soon after taking the toxic dose there is severe pain in the stomach and bowels, accompanied by violent vomiting and persistent purging; the heart's action becomes depressed and irregular, the pulsations sometimes being reduced to one half or one quarter of the normal; there is great thirst, the surface is pale and moist, and the extremities become cold; the pupils are usually dilated and vision is imperfect, and, according to Tardieu, the sclerotic frequently assumes a characteristic blue tint; delirium often sets in, accompanied by convulsions, and death occurs through syncope.

Digitalis is a cumulative poison. Frequently no effects are shown until a number of doses have been taken, when suddenly the toxic effects of the drug may be violently manifested. Many cases are recorded in which no untoward symptoms were produced until the drug had been taken for a number of days, when the full poisonous force of the digitalis suddenly appeared.

Period when Fatal.—Digitalis generally produces death slowly, a fatal termination rarely occurring earlier than the end of twenty or twenty-four hours, and it may be postponed for a number of days. One case is recorded of death on the sixth day, another on the twelfth day, and another at the end of three weeks.

Fatal Quantity.—It is quite difficult, if not impossible, to state the minimum fatal dose of digitalis. The drug, as is well known, varies in its activity according to its age and the care taken in the selection and curing of the leaves. All the pharmaceutical preparations consequently are of variable strength, and the digitalins of commerce are also quite uncertain in their activity. Moreover, the cumulative effect of the drug makes it still more difficult to estimate the exact intensity of action of a single dose. Two or three grains of the powdered leaves have occasionally produced severe symptoms, and eight or ten grains may be regarded as a dangerous and possibly even fatal dose. Very large quantities, however, of the drug and its preparations, such as a dram of the leaves and a half-ounce or an ounce of the tincture, have been administered without producing untoward symptoms, but it is probable that in these cases the article employed was largely inert.

Treatment.—The stomach should be evacuated as soon as possible. If vomiting is already present, as is usually the case, it should be encouraged by copious draughts of tepid water so as thoroughly to wash out the stomach; but if vomiting has not occurred spontaneously, it should be produced by an emetic, or the stomach should be freed from its contents by the stomach-pump or stomach-tube. Tannic acid, or vegetable infusions containing it, may be copiously administered, since the active principles of digitalis are rendered sparingly soluble by this agent. The pain may be combated by small doses of opium, and the depressing effects of the drug should be counteracted by the use of stimulants, such as alcohol, ammonia, electricity, and external heat. Above all things, the patient should be kept quiet, and always in a recumbent position, in order that the least possible work may be thrown upon the heart. Death has not infrequently occurred from syncope upon the patient getting out of bed, or even sitting up.

Post-mortem Appearances.—As with most other vegetable poisons, no characteristic post-mortem appearances are produced by digitalis. Sometimes there is injection of the mucous membrane of the stomach and the membranes of the brain, but often these are lacking, and absolutely nothing abnormal presents itself. Digitalis or its active principles, therefore, may produce death and leave no post-mortem appearances even remotely to suggest its administration.

Tests.—Unfortunately, we do not possess at present any conclusive chemical tests either for digitalis or its active principles. The nearest approach to characteristic reactions are the two following:

(*a*) *Grandeau's Test.*—Digitalin dissolves in concentrated sulphuric acid with the production of a green color, which on the addition of bro-

mine changes to a violet red, and again becomes green on dilution with water.

(*b*) *Lafon's Test.*—If digitalin is gently heated with a few drops of a mixture of equal parts of alcohol and sulphuric acid a light yellowish-brown color is developed, which on the addition of a drop of dilute solution of ferric chloride changes to a beautiful blue, or greenish-blue color, which persists for several hours.

Neither of these chemical tests, however, is entirely conclusive, and we are obliged to depend chiefly upon the physiological effects of the drug for its recognition in toxicological examinations. The gastro-intestinal symptoms and the remarkable slowing of the heart's action are well shown when the substance is administered to one of the lower animals, and this is our principal means of determining the presence of the poison.

Detection of the Poison.—Vomited matter, the contents of the stomach, or other suspected material, should be mixed with alcohol, slightly acidulated with acetic acid, and digested on the water-bath at a slight elevation of temperature for some time. The mixture is then strained and the filtrate freed from alcohol by slow evaporation at a moderate temperature. The resulting aqueous fluid is shaken with petroleum ether, which dissolves out many foreign bodies but does not remove the active principles of the digitalis. After separating the ether, the liquid is shaken with chloroform, which upon spontaneous evaporation leaves behind the toxic principles of the drug, associated usually with a considerable amount of foreign material. A little of the residue should be given by hypodermic injection to a cat or small dog, and the effects carefully watched. If digitalis, or one of its preparations, was present in the material examined, the animal should show the toxic effects of the drug by vomiting and purging, dilatation of the pupils, slow and irregular heart-action, and, if the dose is sufficiently large, by death at the end of a number of hours. Another portion of the residue may be administered to a frog, and its exposed heart carefully watched. At the same time another frog should be treated with a small quantity of known digitalin, and a third untreated animal should be used as a standard of comparison. If the effect of the suspected extract on the heart is the same as that of the digitalin, we know at least that some heart-poison is present. If these several physiological tests give positive results, a portion of the chloroform extract may be submitted to the two chemical tests before described; and while their results by themselves alone cannot be regarded as very conclusive, yet in conjunction with the tests with animals they are often of much value in deciding as to the presence or absence of digitalis.

Resistance to Putrefaction.—Digitalis and its active principles resist decomposition in the body after death for at least a moderate period. In the well-known De la Pommerais case at Paris, the deceased was exhumed thirteen days after death, and extracts of the organs produced physiological effects indicating the presence of digitalin; and recently Lafon has demonstrated that digitalin is not decomposed by the various fluids of the gastro-intestinal tract, and that it resists for a considerable length of time the destructive influence of the microbes of putrefaction.

CHLOROFORM.

Chloroform is a colorless, neutral liquid, of specific gravity 1.5; it is possessed of an agreeable odor and of a burning and slightly sweetish taste. It is sparingly soluble in water, but mixes in all proportions with alcohol and ether. It is readily volatile at ordinary temperatures, and boils at 61° C. Its composition is represented by the formula $CHCl_3$.

Chloroform in sufficient dose is possessed of poisonous properties whether taken as a liquid by the mouth or inhaled as a vapor into the lungs. As the effects are somewhat different in the two cases, each should be considered separately.

(a) *As a Liquid by the Mouth.*

Symptoms.—Chloroform taken by the mouth presents two distinct classes of symptoms: those produced by its local irritant action, and those developed by its effects upon the nervous centers.

Immediately after swallowing a poisonous dose of liquid chloroform there is experienced an intense burning sensation in the mouth, throat, and stomach; this is usually, although not always, accompanied by vomiting, and the vomited matter is not infrequently mixed with blood. As the chloroform, however, is absorbed and its sedative effects upon the nervous centers are developed, vomiting ceases. Profound narcotic effects now manifest themselves. The patient becomes drowsy and falls into a deep stupor; the face is pale, moist, and frequently cyanotic; the pulse becomes feeble and irregular, the breathing is stertorous, and convulsions often occur. Death takes place either from paralysis of the heart or asphyxia.

Period when Fatal.—Chloroform when taken by the mouth acts usually somewhat slowly, death not generally occurring for ten or twelve hours. One case, however, is recorded in which there was a fatal termination in three hours; but, on the other hand, another is reported in which life was prolonged until the eighth day.

Fatal Quantity.—A little less than half an ounce of chloroform has proved fatal to an adult, and this quantity may be regarded as probably the minimum fatal dose. Children, however, as would naturally be expected, are much more sensitive to its effects, and the death of a child is reported from a dram of the fluid. Large doses have been recovered from, four ounces having been taken in one case and the person survived.

Treatment.—The stomach should be promptly evacuated, and this is best done by means of the stomach-pump or stomach-tube, as the sedative influence of the drug upon the nervous system makes emetics uncertain in their action.

The depressing effect of the poison should be combated by hypodermic injections of strychnine and ammonia. The patient should be kept warm, and should be aroused from slumber as much as possible by persistent conversation. Artificial respiration may be resorted to if necessary, and electricity is often useful in stimulating the respiratory center. If there is much cyanosis, inhalations of pure oxygen are frequently beneficial.

Post-mortem Appearances.—The mouth, throat, and stomach are usually intensely reddened by the local irritating action of the poison, although these appearances are sometimes wanting. The blood is generally dark and fluid, the vessels of the brain are frequently gorged with blood, and there is usually congestion of the lungs and often of the liver and kidneys.

(*b*) *As a Vapor by the Lungs.*

Symptoms.—Vapor of chloroform when inhaled produces at first a moderate general excitement of the system, but this is rapidly followed by drowsiness, deep sleep, and complete insensibility. If chloroform is given in moderation and mixed with sufficient air, anæsthesia may be maintained with but slight danger for a considerable period of time, as is often done during surgical operations; but if too great a quantity is used, or the amount of air with which the vapor is mixed is too small, it acts as a narcotic poison, producing cyanosis, stertorous breathing, irregular heart-action, convulsions, and death, the latter occurring sometimes through heart failure and sometimes through paralysis of the respiratory center.

Even with the most skillful administration the vapor of chloroform sometimes produces death, notwithstanding the amount given is small and largely diluted with air. The records of surgery contain many such cases.

Treatment.—The patient should be put in a well-ventilated place with an abundance of fresh air blowing over the face, but the body should be kept warm, artificial heat being used if necessary. If breathing has ceased, artificial respiration should be resorted to, and pure oxygen, if possible, should be allowed to play freely over the face at the same time. Electricity may be employed to stimulate the respiratory and circulatory centers, and inhalations of amyl nitrite may sometimes be given with advantage.

Fatal Quantity and Fatal Period.—Both the fatal quantity and fatal period of chloroform when taken by inhalation are uncertain. Persons have died almost as soon as the administration of the vapor was commenced, and, on the other hand, death has not occurred until a large quantity of the drug had been inhaled for a considerable period of time. Some persons appear to be highly sensitive to the action of this agent, while others bear it in large amount without unfavorable symptoms. It may be stated, perhaps, that the fatal dose ranges from a few whiffs of the vapor to many ounces, and the fatal period from a few minutes to several hours.

Post-mortem Appearances.—The appearances after death are similar to those observed after the ingestion of liquid chloroform, excepting the redness produced by the local irritation of the latter in the mouth, throat, and stomach.

Tests.—The test for chloroform upon which we mainly rely in toxicological examinations depends upon the fact that the vapor of chloroform if passed through a tube heated to redness is decomposed, being broken up into carbon, hydrochloric acid, and free chlorine. The hydrochloric acid and chlorine thus produced may be readily recognized by the reddening effect of the one and the bleaching action of the other on blue litmus, by their liberating iodine from potassium iodide, and by

their producing, when brought in contact with silver nitrate solution, a white precipitate of silver chloride, which is insoluble in nitric acid but readily soluble in ammonia.

Detection of the Poison.—If the chloroform was taken by the mouth the contents of the stomach usually give the most positive evidence of the poison, although the blood and lungs may also be examined; but when death has occurred from inhalation of the vapor, the lungs generally afford the most certain results, although the blood should also be tested.

The material under examination should be finely comminuted and placed in a flask provided with a doubly perforated stopper, through which pass two glass tubes—one reaching nearly to the bottom of the flask, while the other goes but a short distance into its upper part. The latter tube is connected with a piece of tubing of hard glass, a section of which is heated to redness in a burner, and a few inches beyond are placed a piece of moistened blue litmus-paper and a strip of filter-paper saturated with starch paste and potassium iodide. The tube is then bent at right angles and dips into a solution of silver nitrate. The flask should be very gently heated by being placed in a dish of warm water, and air is slowly blown through the mixture by means of the longer tube. If chloroform is present the stream of air carries it off in the form of vapor, and as it traverses the heated tube it is decomposed, yielding hydrochloric acid and chlorine. The mixture of the two as it comes in contact with the piece of blue litmus-paper first turns it red and then bleaches it, while the paper impregnated with starch paste and potassium iodide is colored blue from the formation of iodide of starch. As the gases bubble up through the solution of silver nitrate, a white precipitate is thrown down, insoluble in nitric acid, but readily dissolving in ammonia. If chloroform is absent, however, these reactions are not observed.

Resistance to Decomposition.—Chloroform is an antiseptic substance, and naturally, therefore, resists decomposition for a considerable period of time. In spite of its volatility it remains tenaciously attached to the tissues of the dead body, and its presence has been demonstrated in the lungs of persons who have died from its effects, several months after burial.

CHLORAL.

Pure chloral is a colorless, oily liquid obtained by the prolonged action of chlorine on alcohol. Its composition is represented by the formula C_2HCl_3O. When brought in contact with water it unites with the latter, producing a substance which is the chloral of the United States Pharmacopœia and of commerce. To distinguish it from the anhydrous liquid chloral it is often termed chloral hydrate, or, more properly, hydrous chloral.

The chloral of commerce is a crystalline solid of neutral reaction, slightly volatile at ordinary temperatures, and possessed of a peculiar odor and disagreeable taste. It is easily soluble in water, alcohol, and ether.

Symptoms.—The effects of chloral are very similar to those produced by chloroform when taken by the stomach. It is not, however, as decided an irritant as chloroform, and therefore does not usually produce the

local burning pains and the vomiting occasioned by the latter, and the symptoms, moreover, usually come on rather more slowly. Not long after taking a poisonous dose great drowsiness appears, succeeded by profound sleep, passing into coma; the face is flushed at first, but afterward becomes pale and finally cyanotic; the breathing is stertorous, the pulse feeble, and death ensues sometimes with, and sometimes without, general convulsions. The pupils are usually contracted and insensible to the light, but occasionally are dilated. The temperature falls, and toward the close the extremities are markedly cold.

Fatal Period.—Chloral, like chloroform, usually leads somewhat slowly to a fatal termination, death rarely occurring before the lapse of from six to eight hours. One case, however, is recorded of a fatal issue in half an hour, and another in an hour.

Fatal Quantity.—The smallest recorded quantity that has produced death is ten grains; this, however, is exceptional, but a number of cases are reported in which twenty, thirty, and forty grains have proved fatal. On the other hand, large doses, such as five and six drams, have been recovered from.

Treatment.—The stomach should be evacuated promptly, preferably by use of the stomach-pump or stomach-tube, as emetics in this form of poisoning are apt to be unreliable. The patient should be put in an airy, well-ventilated place, but should be kept warm by artificial heat. The heart and respiration should be stimulated by hypodermic injections of strychnine and ammonia, and by the use of electricity. If breathing threatens to cease, artificial respiration should be resorted to, and pure oxygen should, if possible, be played over the face at the same time.

Post-mortem Appearances.—These are neither characteristic nor constant, those most usually seen being congestion of the lungs, brain, spinal cord, and, occasionally, of the mucous membrane of the stomach and bowels.

Tests.—Chloral, when heated with an alkaline hydrate, is decomposed, chloroform being formed, which may be recognized in the manner already described under that substance. This constitutes the test commonly employed for chloral.

Detection of the Poison.—The material, such as vomited matter, the contents of the stomach, or one of the organs, as the liver, kidneys, or brain, should be finely comminuted, rendered neutral in reaction, and placed in an apparatus such as is described under chloroform. A test for the presence of chloroform is then made, and if this is found negative the material is rendered alkaline by the addition of potassium hydrate solution and the test for chloroform repeated. If a reaction is now obtained the presence of chloral is established.

Resistance to Decomposition.—Chloral is a strong antiseptic, and is not infrequently used as a preservative agent. It undoubtedly, therefore, would strongly resist decomposition, and probably might be detected in the body a considerable period after death.

CARBOLIC ACID.

Carbolic acid, known also as phenol and phenyl hydrate, is represented by the chemical formula C_6H_5OH. It is found in commerce chiefly in two forms: crude carbolic acid, a reddish or brownish-red liquid, and

pure carbolic acid, a crystalline solid at ordinary temperatures, but melting easily on moderate warming. It is quite volatile, and has a peculiar disagreeable odor and a burning taste, which is somewhat sweetish when diluted. It takes up about five percent. of water to form a liquid, which is often called liquefied or ninety-five-percent. carbolic acid. It dissolves in about twenty parts of water, and is readily soluble in alcohol, ether, and glycerine. It coagulates albumen, and whitens the skin or mucous membrane to which it is applied.

Symptoms.—Carbolic acid has a dual action as a poison: first, that of a local irritant or escharotic to the mouth, throat, and stomach, and second, that of a profound sedative to the nerve-centers after absorption. The symptoms usually come on very rapidly, frequently immediately after the poison is swallowed. There is intense burning in the throat and stomach, attended sometimes by vomiting, although this is often entirely lacking. Stupor sets in, frequently accompanied by delirium, and finally passing into coma. The pulse is generally feeble and irregular, the breathing is often stertorous, and death is sometimes preceded by convulsions.

The odor of carbolic acid is usually easily perceived in the breath, and the urine has a greenish-brown color, becoming of a marked smoky hue on exposure to the air.

Carbolic acid has not infrequently produced serious symptoms, and even death, by its external application.

Period when Fatal.—Carbolic acid generally acts with moderate rapidity, death occurring in from two to four hours, and one case is recorded of death within three minutes. A fatal termination, however, is sometimes long delayed, death not supervening for a number of days.

Fatal Quantity.—The smallest recorded fatal dose of carbolic acid is one dram, and numerous cases are reported of death from two drams and upward.

Treatment.—The stomach should be promptly evacuated by the use of the stomach-pump or stomach-tube, and the organ washed out with tepid water. Great care should be used in introducing the tube into the stomach, for the acid having corroded the œsophagus, there is danger of its perforation. Emetics are generally of but little utility on account of the sedative influence of the poison both on the stomach locally, and upon the nervous system after absorption. After evacuating the stomach, bland mucilaginous drinks may be given, and soluble sulphates, such as those of sodium and magnesium, should be freely exhibited, so as to favor the conversion of the carbolic acid into conjugated sulpho-compounds. Morphine may be administered for the relief of pain, and in case of great depression ammonia and alcohol are useful. The patient should be kept warm, and artificial respiration is necessary in case breathing threatens to cease.

Post-mortem Appearances.—The odor of carbolic acid is usually distinctly observed both in the stomach and in other parts of the body. The mucous membrane of the mouth and throat is white, and that of the stomach and intestines is reddened and softened. The brain is generally congested, and frequently also the lungs, liver, and kidneys. The blood is dark and fluid. Sometimes, however, no abnormal post-mortem appearances are observed.

Tests.—In addition to the odor, which is fairly characteristic, we have a number of tests, of which the following are among the best.

(*a*) *Bromine Test.*—If bromine water is added in excess to a solution of carbolic acid, a yellowish precipitate is thrown down, even if the solution contains only one part to 50,000. If the precipitate is collected, washed, mixed with sodium amalgam and water, and warmed, the odor of carbolic acid is given off upon acidifying the mixture with sulphuric acid.

(*b*) *Hypochlorite Test.*—If carbolic acid is mixed with ammonia water and then a solution of a hypochlorite added, a blue color is developed.

(*c*) *Ferric Chloride Test.*—Carbolic acid with neutral solution of ferric chloride gives a permanent blue color.

None of the above tests are entirely characteristic of carbolic acid, a number of other substances responding to one or all of the reactions. The only other body, however, which would be likely to be confounded with it is creosote. This behaves with the above tests very much like carbolic acid, but the two may be distinguished by the fact that creosote when mixed with collodion does not coagulate the latter, while carbolic acid does; and the blue color produced by the action of ferric chloride and creosote rapidly changes to brown, while that developed with carbolic acid is permanent.

Detection of the Poison.—The parts to be examined should be finely subdivided, mixed with water, gently acidulated with sulphuric acid, and, after moderate digestion, filtered; the filtrate is placed in a retort and subjected to distillation. The distillate may be examined directly by the tests already given, but if the amount of carbolic acid present is small it is better to shake up the distillate with ether, which absorbs the carbolic acid and afterward leaves it behind upon spontaneous evaporation in a watch-glass or beaker. The residue thus obtained may be dissolved in a small amount of water, and the solution examined by the various tests given above.

In addition to the foregoing there is a very large number of other poisonous organic compounds; most of them, however, are so rare or are so seldom used for the purposes of criminal poisoning, that they possess but little medico-legal interest, and cannot justly claim admission within the somewhat narrow limits of this article. A few, however, of possibly greater importance than others, may be briefly mentioned.

Croton Oil.—When taken in toxic quantity croton oil acts as a violent gastro-intestinal irritant, and the *symptoms* are those commonly observed in poisoning by such agents. There is intense burning and pain in the mouth, throat, stomach, and bowels, accompanied by violent vomiting and purging, slow and feeble pulse, cold extremities, profound prostration, collapse, and death.

Two or three drops of the oil have frequently produced distressing gastro-intestinal irritation, and twenty drops have occasioned death.

The *treatment* should consist of prompt evacuation of the stomach, the exhibition of demulcent drinks, and the administration of anodynes as occasion requires.

The post-mortem appearances are those usually found as the effect of gastro-intestinal irritants, and consist chiefly of marked inflammation of the stomach and intestines.

The detection of the poison is accomplished by repeatedly extracting the contents of the stomach and bowels with ether, allowing the latter to

evaporate, and applying a small particle of the residue to the inside of the arm. If croton oil is present the surface will be blistered. We have no reliable chemical test for the oil when present in the small quantity usually found in toxicological examinations.

Cantharides, or Spanish Fly.—The *symptoms* produced by a poisonous dose of cantharides somewhat resemble those occasioned by croton oil, both substances being active gastro-intestinal irritants. There is great burning in the throat and stomach, intense thirst, violent vomiting, and severe diarrhœa; the mouth and throat are blistered, the salivary glands swollen, and salivation frequently supervenes. The poison is largely eliminated by the urine, and in passing through the urinary tract intense irritation of all parts of these organs is produced, accompanied by severe pain in the back, strangury, and bloody urine. As the case progresses the extremities become cold, and the patient sinks into collapse, followed by coma and death.

Small doses of the drug, like a single fly, may occasion intensely poisonous symptoms, but twenty or thirty grains are usually necessary to produce fatal effects. Recovery, however, may follow quite large quantities, although in these cases distressing after-effects nearly always persist for weeks and even months.

The treatment of cantharides poisoning should consist of promptly evacuating the stomach, the exhibition of demulcent drinks, allaying the pain with morphine, and sustaining the patient during collapse by stimulants.

The post-mortem appearances embrace marked inflammation of the stomach and bowels, with destruction of the mucous membrane in spots, intense reddening and congestion of the kidneys, and injection of the bladder.

In making an examination for the *detection of the poison* the contents of the stomach and bowels should first be carefully examined for the presence of portions of the insect, which are often found if the crude drug was taken; but if a fluid preparation such as the tincture was used, parts of the fly would naturally not be discovered. The material may be examined chemically by Dragendorff's process as follows: The suspected substance is boiled with solution of potassium hydrate until it is of uniform fluid consistence; the mixture is then acidified and mixed with four times its bulk of strong alcohol, heated, and filtered hot; the filtrate is gently warmed to expel the alcohol, and is then shaken with chloroform; the latter is allowed to evaporate, and leaves behind the active principle of cantharides, known as cantharidin. The residue should be dissolved in a little warm oil and applied to the breast, the inside of the arm, or behind the ear, when blistering will be produced if cantharides was present.

Camphor.—This substance, although regarded commonly as quite innocent, if taken in large doses is capable of producing severe symptoms of poisoning, and it not infrequently has occasioned death. In toxic quantities it acts as a local irritant to the gastro-intestinal tract, and produces first stimulation, and subsequently paralysis of the nerve-centers.

The symptoms vary considerably, according to the dose and the mode of administration, but there is generally pain in the stomach, accompanied by vomiting, dizziness, cold and clammy surface, weak pulse, labored breathing, coma, and convulsions.

Thirty grains have proved fatal to a child, and smaller quantities have occasioned severe symptoms in adults.

The treatment should consist in thorough evacuation of the stomach and bowels, and the use of anodynes and supporting measures as needed.

The post-mortem appearances are generally limited to inflammation of the stomach and bowels, and injection of the membranes of the brain.

The contents of the stomach or other suspected material may be examined for camphor by extracting thoroughly with chloroform, and allowing the latter to evaporate, when the camphor will be left behind, and can be readily recognized by its odor and its other physical properties.

Cocculus Indicus.—This owes its poisonous properties to the presence of picrotoxin, a colorless, crystalline body, of intensely bitter taste, sparingly soluble in water, but readily soluble in alcohol, ether, and chloroform. It is not an alkaloid, having no nitrogen in its composition, but is probably a glucoside. Both the crude drug and its active principle are gastro-intestinal irritants, and also powerful stimulants of the nerve-centers. When taken in poisonous doses they occasion vomiting, dizziness, unconsciousness, and convulsions. The latter in some respects bear a resemblance to those produced by strychnine.

The treatment should consist in evacuating the stomach thoroughly, and if convulsions are present, in the administration of chloral by the mouth or chloroform by the lungs.

The post-mortem appearances are not constant. There is usually some inflammation of the stomach and congestion of the membranes of the brain.

The contents of the stomach, or other suspected material, may be examined for the poison by thoroughly exhausting with alcohol, evaporating to a small bulk, and extracting the residue with chloroform. The latter upon evaporation will deposit crystals of picrotoxin, which may be recognized by its physiological effects on the lower animals, and also by the fact that when mixed with an excess of potassium nitrate, the mixture moistened with a little sulphuric acid, and strong solution of sodium hydrate added, a brick-red color is developed.

THE TOXICOLOGICAL IMPORTANCE OF PTOMAÏNES AND OTHER PUTREFACTIVE PRODUCTS.

BY

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PUTREFACTION consists of the splitting up of complex molecules into simpler ones by the agency of micro-organisms. Among those molecules which result from the action of bacteria, certain ones are basic in character. These are known as ptomaïnes. A ptomaïne may, therefore, be defined as a basic product of putrefaction, or a putrefactive alkaloid. Ptomaïnes have been called animal alkaloids, but this is a misnomer, because they may result from the putrefaction of vegetable as well as of animal substances. Besides, the term "animal alkaloid" is more strictly applicable to those basic substances which result from the chemical activity of the cells of the animal body wholly independent of bacterial agency. Like the vegetable alkaloids, ptomaïnes may be volatile or non-volatile. All contain nitrogen; some contain oxygen, while others do not. The latter correspond to the volatile vegetable alkaloids, nicotine and coniine, and the former correspond to the fixed alkaloids.

Since all putrefaction is due to the action of bacteria, it follows that all ptomanïes result from the growth of these micro-organisms. The kind of ptomaïne formed will depend upon the individual bacterium engaged in its production, the nature of the material being acted upon, and the conditions under which the putrefaction proceeds, such as the temperature, amount of oxygen present, and the duration of the process. Generally speaking, in all toxicological research the tissue under examination has undergone putrefactive changes in the absence of air. Therefore those products which are formed by anaërobic bacteria are the ones which concern us especially. This fact seems to have been overlooked by the majority of toxicologists. Its importance is great, and it renders worthless the great number of experiments which have been made upon tissues allowed to decompose in the presence of an unlimited air-supply. Bacteria are always present in certain portions of the alimentary canal and in certain other cavities of the body. The death of the host does not mean the death of these bacteria. On the contrary, it enables them to extend their growth to adjacent tissues, until the whole of the cadaver may be involved.

Ptomaïnes are present probably to a greater or less extent in every organ which is submitted to the toxicologist for examination. If he be ignorant of the nature of these substances, he may mistake them for

vegetable alkaloids, and making this mistake, he may report a given poison present when it is not present, and thus lead to the conviction of an innocent person. This whole subject needs thorough study. It is a new line of work, which has not been followed to any great extent, and the amount of information which we have concerning these substances is very small and inadequate.

It must not be understood that basic substances are the only putrefactive products which may interfere with the tests for vegetable alkaloids. Other products of putrefaction besides those which are basic in character must also be taken into consideration; for instance, certain proteids, notably albumoses and peptones, are marked reducing agents, and give certain color reactions, such as the reduction of ferric salts, which may lead us into error. Then there are organic acids, some of which have been identified, while the nature of others remains undetermined, which may lead us into the same error. It is the purpose of this paper to point out the few facts which we do know concerning those putrefactive substances, which may seriously modify the tests which have heretofore been considered as positive.

THE PURITY OF REAGENTS.

One of the first things to be ascertained by the chemist who undertakes to do toxicological work is the purity of his reagents. Especially is this true in the employment of alkaloidal solvents. The writer has found a number of samples of German ether, which was imported on account of its supposed purity, to yield on spontaneous evaporation a residue which gave several of the alkaloidal reactions, and a few drops of which, injected under the skin of a frog, caused paralysis and death within a few hours. In the use of ether I would advise that 500 c.c. of this reagent be allowed to evaporate spontaneously, and the residue, if there be one, be examined both chemically and physiologically. The basic substance which is found in some samples of sulphuric ether is pyridine. Commercial alcohol almost invariably contains small quantities of an alkaloidal substance the odor of which is similar to that of nicotine and pyridine. Solutions of this substance are precipitated by gold chloride, phospho-wolframic acid, phospho-molybdic acid, potassium iodide, and Meyer's reagent, but not by platinum chloride or tannic acid. It does not reduce, or reduces feebly, ferric chloride. From one sample of alcohol Guareschi and Mosso obtained a base which, in addition to the above reactions, did give a precipitate with platinum chloride. Alcohol may be freed from these substances by distillation over tartaric acid. Chloroform sometimes leaves a marked residue on evaporation. When this is the case, the chloroform should be washed first with distilled water, then with distilled water rendered alkaline with potassium carbonate, then dried over calcium chloride, and distilled. Petroleum ether and benzole sometimes contain a base which has an odor similar to that of trimethylamine or pyridine, and which gives a precipitate with platinum chloride, crystallizing in octahedra. Of all the solvents used in the extraction of vegetable alkaloids, amylic alcohol is the one most likely to lead the chemist into serious error. This fact is due to two causes: in the first place, the amylic alcohol itself is very likely to contain impuri-

ties—in one sample Haitinger found as much as .5 percent. of pyridine; the second source of danger in amylic alcohol lies in the fact that it is a ready solvent for many of the putrefactive alkaloids. For this reason the amylic alcohol residue is probably less suitable than any other for the application of color tests in the final identification of poisons. Amylic alcohol, when found to be impure, may be rectified in the same manner as recommended above for ethylic alcohol.

I will now give a brief account of those substances which have been found to resemble in their reactions the vegetable alkaloids.

CONIINE.

At present it is very difficult, probably impossible, for the chemist to state with absolute certainty that he has detected true coniine in the dead body. Before he can do this even with a reasonable degree of certainty, the symptoms and the post-mortem appearances must conform with those induced by the vegetable alkaloid, the analysis must be made before decomposition sets in, and the amount of the base found must be sufficient for physiological experiments to be made with it.

Brouardell and Boutmy found in the body of a woman who had died after suffering from choleraic symptoms caused by eating of a stuffed goose, a base which gave the odor of coniine and the same reactions with gold chloride, iodine in potassium iodide, etc., as coniine. The same base was found in the remainder of the goose. This substance did not give the red coloration with the vapor of hydrochloric acid, and it did not form butyric acid on oxidation, and although it was poisonous it did not induce in frogs the symptoms of coniine poisoning. Selmi repeatedly found coniine-like substances in decomposing animal tissue. By distilling an alcoholic extract from a cadaver, acidifying the distillate with hydrochloric acid, evaporating, treating the residue with barium hydrate and ether, and allowing the ether to evaporate spontaneously, he obtained a residue of volatile bases, the greater part of which consisted of trimethylamine. After removing this base, the residue had the odor of the urine of the mouse. Later, Selmi obtained an unmistakable coniine odor from a chloroform extract of the viscera of a person who had been buried six months, and in another case ten months after burial. The chloroform residue was alkaline in reaction, and when dissolved in a few drops of water and allowed to evaporate on a glass plate it gave off such a penetrating odor that the chemist was compelled to withdraw from close proximity to the substance. The odor imparted to the hands in testing the substance with the general alkaloidal reagents remained for half an hour. This volatile base seemed to be formed by the spontaneous decomposition of other ptomaïnes. An aqueous solution of a ptomaïne obtained by Selmi by extraction with ether according to the Stas-Otto method from the undecomposed parts of a cadaver had no marked odor, but after having been kept for a long time in a sealed tube, it not only gave off a marked coniine odor, but the vapor turned red litmus-paper blue. Selmi also obtained a ptomaïne from putrid egg albumen. After converting this base into a sulphate, and allowing it to stand, it formed in two layers, one of which was a golden yellow liquid; and this, on being treated with barium hydrate, gave off ammonia, and later the odor

of coniine. Finding that butyric and acetic acids were formed by the oxidation of this base, Selmi concluded that he had real coniine or methylconiine, and that it was formed by the oxidation of certain fixed ptomaïnes, or by the action of amido bases on volatile fatty acids. For these reasons Selmi believed in the bacterial origin of coniine or closely allied bases, also in the existence of a "cadaveric coniine."

In a criminal trial in east Prussia, Sonnenschein found a substance which he believed to be the alkaloid of the water-hemlock, but Otto, Husemann, and others believed it to be a cadaveric coniine. Otto says that the symptoms reported in the case were not those of either coniine or cicuta. This base was obtained six weeks after the exhuming of the body, which had been buried for three months. It had the odor of coniine, the taste of tobacco, and gave with potassium bichromate and sulphuric acid the odor of butyric acid, and behaved with reagents like coniine.

The most celebrated trial in which a putrefactive coniine has figured was the Brandes-Krebs investigation, which took place in Braunschweig in 1874. Two chemists obtained from the undecomposed parts of the body, in addition to arsenic, an alkaloid which they pronounced coniine. This substance was referred to Otto for further examination. He reported that it was neither coniine nor nicotine, nor any vegetable alkaloid with which he was acquainted. He converted the substance into an oxalate, dissolved it in alcohol, evaporated the alcohol, dissolved the residue in water, rendered the solution alkaline with potash, and extracted the base with petroleum ether. On evaporation of the petroleum ether the alkaloid appeared as a bright yellow oil, which had a strong, unpleasant odor, quite different, however, from that of coniine. It was strongly alkaline, and had an intensely bitter taste. At ordinary temperature it was volatile. From its aqueous solutions it was precipitated by the chlorides of platinum, mercury, and gold. In these reactions it resembled nicotine, from which, however, it differed in the double refracting and crystalline character of its hydrochloride. With an ethereal solution of iodine this substance did not give the Roussin test for nicotine, but instead of the long, ruby-red crystals there appeared small dark-green needle-shaped crystals. The substance was found to be highly poisonous. Seven centigrams injected subcutaneously into a large frog produced instantaneous death, and forty-four milligrams given to a pigeon caused a similar result. On account of its poisonous properties the jury of medical experts decided that the substance was a vegetable alkaloid. The reason for this decision certainly must now be regarded as wholly inadequate. We know that some of the most highly poisonous substances are found among putrefactive products.

In examining the stomach and intestines in a case of suspected poisoning, Liebermann found in the ether extract from alkaline solution a brownish, resinous mass, which dissolved in water to a turbid solution, the cloudiness increasing on heating. The aqueous, strongly alkaline solution of this substance gave the following reactions:

First, with tannic acid, a white precipitate.

Second, with potassium iodide, a yellow brown, turning to dark-brown precipitate.

Third, with chlorine water, a marked white cloudiness.

Fourth, with phospho-molybdic acid, a yellow precipitate.

Fifth, with potassio-mercuric iodide, a white precipitate.

Sixth, with mercuric chloride, a white cloudiness.

Seventh, with concentrated sulphuric acid after standing, a reddish violet coloration.

Eighth, with concentrated nitric acid after evaporation, a yellowish spot.

This substance might have been easily confounded with coniine, but the odor differed from that of the vegetable alkaloid. Moreover, the putrefactive substance did not distil when heated on the oil-bath to 200° C., while coniine distils at 135° C. Lastly, the putrefactive substance may be distinguished from coniine by the non-poisonous properties of the former.

NICOTINE.

Schwanert, in examining the decomposing intestines, liver, and spleen of a child which had died suddenly, perceived a peculiar odor, and obtained in the ether extract from alkaline solution small quantities of a base which was distinguished from nicotine only by its greater volatility and its peculiar odor. Supposing that this substance was produced by decomposition, and in order to ascertain the truth of this supposition, he took the organs of a cadaver that had lain for sixteen days at a temperature of 30° C., and was well decomposed, treated this with tartaric acid and alcohol, extracted first the acid solution with ether, and then the alkaline solution with the same reagent. The last-mentioned extract gave on evaporation the same substance which he had found in the organs of the child. The residue was a yellowish oil, having an odor somewhat similar to propylamine, and was alkaline in reaction, and bitter, but not repulsive, to the taste. With hydrochloric acid it formed white needles, which were freely soluble in water and soluble with difficulty in alcohol. These crystals dissolved in sulphuric acid, forming a solution which was at first colorless, but gradually became dirty brownish yellow and grayish brown on the application of heat. On being warmed with sodium molybdate, a splendid blue color becoming gradually green was produced. Potassium bichromate and sulphuric acid gave a reddish brown passing into a grass-green color. Nitric acid gave a yellow, and tartaric acid solution of the crystals produced on the addition of platinum chloride a dirty yellow precipitate of small, six-sided stars. Gold chloride gave a pale-yellow amorphous precipitate; mercuric chloride yielded white crystals; potassio-mercuric iodide a dirty white precipitate; and potassio-cadmic iodide yielded no result. Tannic acid produced only a turbidity; sodium phospho-molybdate gave a yellow flocculent precipitate, which became blue on the addition of ammonia.

Wolckenhaar obtained from the decomposing intestines of a woman who had been dead six weeks, by extraction with ether from an alkaline solution, a base which bore a close resemblance to nicotine. This substance, at first yellow, on being exposed to the air gradually became brownish. It had a strongly alkaline reaction, and gave off a marked nicotine odor. It was soluble in all proportions in water, and the solutions, which did not become cloudy on the application of heat, had no bitter taste, but were slightly pungent. The peculiar odor did not disappear on saturating the base with oxalic acid. The hydrochloride was brownish, had a strong odor, and became moist on exposure to the air.

Under the microscope it showed no crystals, differing in this respect from nicotine hydrochloride. It differed from nicotine also in its reactions with potassio-bismuthic iodide, gold chloride, iodine solution, mercuric chloride, and platinum chloride. It also failed to give the Roussin test for nicotine. Moreover, it could not be identified with trimethylamine, sparteine, mercurialine, lobeline, or other fluid and volatile bases.

STRYCHNINE.

In a criminal prosecution at Verona, Ciotta obtained from the body, which had only slightly decomposed, an alkaloid which gave a crystalline precipitate with iodine in hydriodic acid, a red coloration with hydriodic acid, and a color test similar to that of strychnine with sulphuric acid and potassium bichromate, and with other oxidizing agents. This substance was strongly poisonous, but did not produce the tetanic convulsions which are characteristic of strychnine. Ciotta pronounced this substance as probably identical with strychnine. Portions of the body were subsequently submitted to Selmi for his opinion. This investigator found the substance giving the above-mentioned color reactions to be amorphous, and that it had only the presumption of a bitter taste, while one part of strychnine in forty thousand parts of water is intensely bitter. Selmi also held that many ptomaïnes give reactions similar to strychnine with iodine in hydriodic acid, and with hydriodic acid alone. He also held that the physiological properties of this substance were such that it could not be strychnine. It could hardly have been aspidospermine, which reacts with sulphuric acid and potassium bichromate similarly to strychnine, because quebracho bark, in which this alkaloid is found, was not at that time used as a medicine, or known in Italy.

There prevails in Lombardy and in adjacent countries a chronic disease known as pellagra. In 1881 Lombardy alone furnished fifty-six thousand cases of this disease. The symptoms may be grouped into three classes: first, those affecting the skin; second, those manifesting themselves in disturbances of the digestive organs; and third, symptoms referable to the central nervous system. The skin first becomes painful, then red and swollen. Soon there is loss of appetite and repugnance to food. Then a severe and exhaustive diarrhœa sets in. Later, delirium and spinal disturbances manifest themselves. Muscular weakness and paraplegia are common among the victims. Post-mortem examination shows numerous small ulcers in the skin and in the intestines, also marked histological changes in certain portions of the spinal cord. According to Paltauf and Heider, this disease is due to infection of the corn-meal, eaten by these people, with the bacillus maidis Cuboni and the bacillus mesentericus fuscus. These germs produce certain ptomaïnes, which are soluble in alcohol, and which cause the disease pellagra. Some of these ptomaïnes give reactions similar to those of strychnine, and agree with this vegetable alkaloid also in their physiological effects, producing tetanic spasms in animals. As early as 1871 Lombroso showed that the extract from moldy corn-meal produced tetanic convulsions in animals. In 1876 Brugnatelli and Zenoni obtained with the Stas-Otto method from this moldy meal an alkaloidal substance which was white, non-crystalline, unstable, and insoluble in water, but readily soluble in

alcohol and ether. With sulphuric acid and bichromate of potassium it yields a color reaction very similar to that of strychnine. Lombroso has named the poisonous substance found in this moldy meal pellagrocine, but this is really a mixture of ptomaïnes, some of which produce narcosis and paralysis, and others produce the symptoms of nicotine poisoning instead of the spasms caused by strychnine.

ATROPINE.

Ptomatropines are frequently met with among the products of putrefaction. They have marked mydriatic properties. To this class belongs a substance observed by Zülzer and Sonnenschein. It was removed from alkaline solutions by ether, and formed microscopic crystals, an aqueous solution of which when applied to the conjunctiva produced a mydriatic effect, and when administered internally increased the action of the heart and arrested the movements of the intestines. Moreover, with certain alkaloidal reagents, such as platinum chloride, it resembled atropine, but when heated with sulphuric acid and oxidizing agents it did not give off the odor of blossoms, Reuss's test. However, Selmi found ptomatropines which, with sulphuric acid and oxidizing agents, did give the blossom odor as distinctly as the vegetable atropine. Some of these putrefactive bases also developed this odor spontaneously after standing for two or three days, and this does not happen with atropine. The odor is also produced with the ptomatropines by nitric and sulphuric acids both in the cold and on the application of heat, while these acids in the cold do not produce the odor with atropine.

Ptomatropines have been found in decomposing fish, corn-beef, putrid game, and poisonous sausage. We do not know as yet whether this is an individual or a class of substances. The symptoms are markedly like those of atropine. The fauces become dry, the gums red and swollen, the secretion of saliva and of sweat is arrested, the muscles of deglutition are partially paralyzed, there is marked mydriasis, paralysis of accommodation, ptosis, and strabismus. In some instances convulsions appear. The heart-beat is in the beginning increased, then markedly weakened. The tongue is coated and the bowels become constipated, there is marked thirst, diplopia, and general weakness. The voice may be wholly lost. Death, which frequently results, is caused, according to Anrep, by paralysis of the heart. Section shows venous hyperemia of the brain, the kidneys, and the lungs, swelling of the pharynx, œsophagus, and mucous membrane of the stomach, with minute hemorrhagic points, cloudy swelling of the solitary follicles and Peyer's patches, and a yellowish-brown colored degeneration of the muscle of the heart.

There is some question as to whether or not any of the ptomatropines will give Vitali's reaction. According to Giotto and Spica, certain ptomatropines do give this reaction. Ptomatropines are probably excreted with the urine in some diseases.

VERATRINE.

Brouardell and Boutmy obtained from a corpse which had lain in water for eighteen months, and a large portion of which had changed into adipocere, a ptomaïne resembling veratrine. It was removed from

alkaline solutions by ether. On being heated with sulphuric acid it became violet. With a mixture of sulphuric acid and barium peroxide it became in the cold brick-red, and, on being heated, violet. With boiling hydrochloric acid it took on a cherry-red coloration. However, it differed from veratrine inasmuch as it reduced ferric salts instantly, and when injected into frogs subcutaneously it did not induce in them the spasmodic muscular contractions characteristic of veratrine.

Bechamp obtained with the Stas-Otto method from the products of the pancreatic digestion of fibrin an alkaloidal body which gave with sulphuric acid a beautiful carmine red similar to that given with veratrine. By digesting this substance with gastric juice and again extracting, he obtained a body which behaved with sulphuric acid similarly to curarine.

DELPHININE.

In 1870 General Gibbone, an Italian of prominence, died suddenly at Rome. His servant was accused of having poisoned him. Two chemists of some reputation reported the presence of delphinine in the viscera. It seemed somewhat improbable that the servant should know anything of so rare a substance, or that he should have been able to obtain it. However, two or more varieties of staphisagria grow in southern Italy, and it was possible that the servant had used some preparation made by himself from the plant. Selmi was called upon to make a further study of this supposed alkaloid. He found that it was removed from alkaline solutions by ether. When heated with phosphoric acid it became red, and when brought into contact with sulphuric acid, reddish brown. In these tests the substance did resemble delphinine, but with sulphuric acid and bromine water, also with Fröhde's reagent, the colorations characteristic of the vegetable product failed to appear. Moreover, Selmi showed that delphinine gave the following reactions, to which the suspected substance did not respond:

First, delphinine dissolved in ether, and, treated with a freshly prepared ethereal solution of platinum chloride, gives a white flocculent precipitate, which is insoluble in an equal volume of absolute alcohol.

Second, delphinine gives precipitates with auro-sodium hyposulphite, and with a sulphuric acid solution of cupro-sodium hyposulphite, the latter precipitate being soluble in an excess of the reagent.

Finally, Ciaccia and Vella showed that while delphinine arrests the heart of the frog in diastole, the suspected substance arrested it in systole.

DIGITALINE.

Rörsch and Fassbender, in a case of suspected poisoning, obtained with the Stas-Otto method a substance which could be extracted from acid as well as from alkaline solutions by ether, and which gave all the general alkaloidal reactions. They were unable to crystallize either extract by taking it up with alcohol and evaporating. The colorless aqueous solution was not at all bitter. The precipitate formed with phosphomolybdic acid dissolved on the application of heat, giving a green solution, which became blue on the addition of ammonia. They believed that

this substance was derived from the liver, because fresh ox liver treated in the same manner gave them a substance which could be extracted with ether from acid as well as from alkaline solutions. Gunning found the same substance in liver sausage from which poisoning had occurred. Rörsch and Fassbender state that while in some of its reactions this substance resembled digitaline, it could be distinguished from this vegetable glucoside by the failure of the ptomaïne to give the characteristic bitter taste. Trottarrelli obtained a similar substance from the brain of a man in whose abdominal viscera he could find no poison. The sulphate of this base gave on evaporation an aromatic-smelling and astringent-tasting residue. It became purple with sulphuric acid alone, and dark red with hydrochloric and sulphuric acids. On frogs this ptomaïne showed no toxic effect.

COLCHICINE.

Baumert found in a suspected case of poisoning, twenty-two months after death, a substance which gave many of the reactions for colchicine. It was extracted from acid solutions with ether, to which it imparted a yellow color. On evaporation of the ether a yellow, amorphous substance remained, and this dissolved in warm water with yellow coloration. It could be extracted from acid solutions also by chloroform, benzol, and amylic alcohol, but not by petroleum ether. It was removed with much more difficulty from alkaline solutions.

All the extracts were yellow, and left on evaporation a feebly alkaline, bitter, sharp-tasting, amorphous yellow residue, which dissolved in water and dilute acids incompletely, forming a resin. When this resin was dissolved in dilute sodium hydrate, and the solution rendered acid by sulphuric acid, the same reactions were obtained as with the original extract.

With phospho-molybdic acid, phospho-tungstic acid, potassio-bismuthic iodide, potassio-mercuric iodide, iodine in potassium iodide, tannic acid, and gold chloride, this substance gave the same reactions which were obtained by parallel experiments with genuine colchicine; thus, the tannic acid precipitates were both soluble in alcohol, and the precipitates with phospho-molybdic acid in both cases became blue on the addition of ammonium hydrate.

Concentrated sulphuric and dilute nitric and hydrochloric acids dissolved the supposed colchicine with yellow coloration. Strong nitric acid (1.4 sp. gr.) colored the substance dirty red, scarcely to be called a violet. When the substance was purified as much as possible, this color became a beautiful carmine red. The addition of water changed the red into yellow, and caustic soda produced a dark, dirty orange.

In general, in the above-mentioned reactions the putrefactive product agreed with the real colchicine, but the former gave precipitates with picric acid and platinum chloride, while the latter gave no precipitates with these reagents.

In 1886 Zeisel proposed the following test for colchicine: When a hydrochloric acid solution of this substance is boiled with ferric chloride, it becomes green, sometimes dark green and cloudy. Now, if the fluid be agitated with chloroform, the chloroform will sink, taking up the coloring matter, and appearing brownish, granite red, or dark, and the supernatant fluid clears up without becoming wholly colorless.

Baumert applied this test to both colchicine and the putrefactive product. To from two to five cubic centimeters of the suspected solution in a test-tube, he added from five to ten drops of strong hydrochloric acid and from four to six drops of a ten-percent. solution of ferric chloride, then heated the mixture directly over a small flame until it was evaporated to half its volume or less. In the presence of one milligram of colchicine the originally bright-yellow solution became gradually olive-green, and, on further concentration, dark green and cloudy. Then, on shaking the fluid with chloroform, admitting as much air as possible, the chloroform subsided, taking a ruby-red color if as much as two milligrams of colchicine were present, and a bright yellow with only one milligram, and the supernatant fluid became of a beautiful olive-green. When ether, petroleum ether, benzol, carbon disulphide, or amylic alcohol was substituted for the chloroform, the coloration did not appear. From this Baumert infers that the red coloring matter is either wholly soluble in chloroform, or that it is not formed until the chloroform is added.

Baumert found this test of great value in deciding whether or not the substance which he found was colchicine. The putrefactive product did not respond to the test.

Some of this substance was sent to Brieger, who decided that it was not a base, but a peptone-like substance. It was also found to be inert physiologically.

Before these investigations were made by Baumert, Liebermann had found the same or a similar colchicine-like substance in a cadaver. His description differed from that of Baumert only in regard to the taste of the substance, Liebermann having failed to observe any marked taste in the body which he found, while, as has been stated, Baumert reported a distinctly bitter taste.

A colchicine-like substance has been found in beer, and it has been suggested that it was this which the above-mentioned toxicologists found in the bodies which they examined; but Liebermann states that the man whose body he examined had been a total abstainer from beer.

MORPHINE.

In the Sonzogna trial at Cremona, Italy, the expert chemists confounded a putrefactive product with morphine. Selmi, who was appointed by the government to investigate the case, demonstrated that the chemists, who had reported the presence of morphine, were in error. This substance was not removed from either alkaline or acid solutions with ether, but could be extracted with amylic alcohol. It reduced iodic acid, but in its other reactions, as well as in its physiological properties, it bore no resemblance to morphine. In frogs it arrested the heart in systole, which is said never to happen in poisoning with morphine. It failed to give both the ferric chloride and the Pellagri tests.

In the same body there was found a substance which was extracted from alkaline solutions with ether, and which gave with hydrochloric acid and a few drops of sulphuric acid, on the application of heat, a reddish residue similar to that obtained by these reagents with codeine, but in its other reactions it did not resemble this alkaloid.

In the examination of a stomach and part of a liver, sent from Lin-

coln, Neb., the writer, following the method of Dragendorff, obtained in the amylic alcohol extract from alkaline solution a residue which gave with more or less distinctness all of the principal color-tests for morphine; but failing to obtain crystals which could be identified with those of this alkaloid, the absence of morphine was reported. Afterward it was quite clearly demonstrated that death in this case had been caused by a blow upon the back of the head with a heavy piece of iron.

The above-mentioned facts induced the writer to undertake some experimental studies upon this point. In this work the author has been greatly aided by one of his students, E. M. Houghton. The results which we have obtained are sufficient to convince us that the identification of morphine in the liver and other organs in cases of suspected poisoning is beset with difficulties not provided for by the methods now generally employed.

Since the substances which vitiate the morphine tests are of bacterial origin, and since bacterial products vary with the conditions under which the germs producing them grow, it is essential that the putrefactive changes which the tissue undergoes before the tests are begun should occur under the conditions, as nearly as possible, which exist in the cadaver. Neglect of this point has undoubtedly been the chief factor in securing the confidence of toxicologists generally in the methods of Dragendorff and Stas-Otto. Many most skillful chemists have carried companion portions of decomposed tissue, one portion with and the other without morphine, through the processes of extraction recommended by Dragendorff, and have obtained satisfactory results, finding that the proper residue responds to the color tests in the one instance and fails to do so in the other. Tissues have been thus tested in apparently every stage of putrefaction, and yet the results have been satisfactory and confirmatory of the methods now generally employed. There is one point, however, which has been constantly overlooked. The putrefaction to which the tissues in these experiments are subjected has been aërobic, while that occurring in the dead body is anaërobic; consequently the putrefactive products are not the same in the two cases. This leads us to state that in all experimental studies of the value of the tests for morphine in decomposing tissue, the decomposition must be allowed to proceed in the absence of oxygen. This is the first point. The second is probably of equal importance, and this concerns the kind of tissue employed. The upper portion of the small intestine (and the adjacent tissue after death) has a bacterial flora peculiar to itself. These tissues are the ones quite universally examined in medico-legal cases, and consist of the small intestine itself, the stomach, the liver, the pancreas, the spleen, and, in some instances, the kidneys. Of course the bacteria present in the small intestines during life may after death extend to all the abdominal and thoracic viscera. Since the liver is so generally examined, we decided to ascertain the effects, if any, of the putrefactive products formed in this organ, decomposing under anaërobic conditions, on the tests for morphine carried out according to the scheme of Dragendorff. Recognizing the fact that arsenic is so frequently employed in the form of an embalming fluid, it was thought best to add this to the liver. The experiment is detailed in the following statement:

Five kilograms of ox liver chopped finely and mixed with two grams of arsenic dissolved in caustic potash, was placed in a large bottle. The

bottle was closed with a cork and sealed with paraffine. A glass tube bent at a right angle was inserted in the center of the cork, while the other end of the tube was connected by means of a short piece of rubber tubing with a Drechsel wash-bottle. The other arm of the wash-bottle was connected with a receiver filled with water. The rubber connecting the large bottle with the wash-bottle was supplied with a clamp.

During the first fifteen or twenty days this clamp was left open, and a large amount of gas passed through the wash-bottle and collected in the receiver. After the above-mentioned time, which varies according to temperature, the passage of gas ceases and the water rises in the receiver, absorbing the collected gas. When this occurred the bottle containing the tissue and the wash-bottle were disconnected, and the clamp on the rubber tubing was closed. By this time the chopped liver has become sufficiently fluid to absorb the gas as fast as it is formed, and unless the bottles are disconnected the water in the wash-bottle may be drawn back into the large bottle.

The fermentation was allowed to continue for thirty days, counting from the beginning. Then the contents of the bottle, decidedly acid in reaction, and giving off a not disagreeable ethereal odor, were poured into a large dish. A considerable portion of the tissue had become fluid by this time.

One kilogram of this decomposed tissue was placed in each of three evaporating-dishes, and these were marked A, B, and C. To B, 130 milligrams of morphine sulphate was added, and to C the same amount of morphine, together with .5 gram each of indol, skatol, and phenol. No addition was made to A. These portions were carried through the manipulations recommended by Dragendorff ("Die gerichtlich-chemische Ermittelung von Giften," dritte Auflage, 1888).

To each 100 c.c. of the fluid 5 c.c. of dilute (1 : 5) sulphuric acid was added. Then 500 c.c. of distilled water was added to each dish, and these were kept at from 40° to 50° C. for eight hours.

Next, each portion was filtered through a falten-filter (No. 572 of Schleicher & Schull). The fluid passed through quickly, and formed a clear, brownish filtrate. The filtrates were evaporated at 50° C. to 600 c.c., and four volumes of absolute alcohol were added to each portion. These mixtures were allowed to stand for twelve hours, and in each a brown resinous precipitate formed. After filtration the alcohol was removed by distillation. A fatty-like residue formed in each flask on the removal of the alcohol, and this was removed by filtration.

The acid solutions were then thoroughly shaken, each with four volumes of petroleum ether. The ethereal layers, when drawn off and evaporated in portions, left very slight residues.

The residues from A and B gave no reactions on the application of the color tests for morphine mentioned below.

The residue from C showed minute traces of indol with nitric acid alone, and with sulphuric acid containing nitric.

The acid solutions were next shaken with benzol. The benzol residues gave no response to the morphine tests.

Chloroform was then employed as a solvent. The residue in this case gave none of the reactions.

The acid solutions were now rendered alkaline with ammonium hydrate, and shaken successively with petroleum ether, benzol, and

chloroform. None of the residues from these solvents responded to the morphine tests.

The alkaline solutions, having been subjected to the above-mentioned processes of purification, were shaken, each with five volumes of amylic alcohol. The shaking was frequently repeated during the afternoon, and then the mixtures were placed in separators and allowed to stand for eighteen hours. The amylic alcohol extracts evaporated on the water-bath gave the following reactions:

Reagent.	*A* *B* *C*
Nitric acid	All gave a lemon-brown color.
Sulphuric acid	None showed any change.
Sulphuric with nitric acid	All gave a lemon yellow, slowly changing to pink.
Ferric chloride	All gave a dirty green.
Iodic acid	All promptly reduced the iodic acid.
Fröhde's reagent	All gave a blue color, without any violet.
Sulphuric acid and cane-sugar	All became brownish red, changing to a wine-red.

Portions of the amylic alcohol extract allowed to evaporate spontaneously showed the same reactions as those given above.

The remaining portions of the amylic alcohol solutions were now shaken with distilled water acidified with sulphuric acid. After separation, portions of the amylic alcohol were evaporated and subjected to the above-mentioned tests, with negative results in each case. This shows that amylic alcohol does not dissolve from acid solutions the substance or substances interfering with the morphine tests.

The acid aqueous solutions of A, B, and C were again rendered alkaline with ammonium hydrate, and shaken with amylic alcohol. The residues from these amylic alcohol extracts were evaporated and subjected to the following tests:

Reagent.	*A* *B* *C*
Nitric acid	All became lemon yellow.
Sulphuric acid	No change in any.
Sulphuric acid with nitric acid	All became lemon yellow.
Ferric chloride	All became bluish green.
Iodic acid	All promptly reduced iodic acid.
Fröhde's reagent	All became blue, with a faint and evanescent purple in B and C.
Pellagri's test	All responded promptly.

The above-mentioned experiment, which has been repeated with no variation in results, convinces us that the tests for morphine by following the scheme of Dragendorff are altogether untrustworthy. Naturally the question arises, What is the nature of the substance or substances which give these color reactions? Quite as naturally the answer that these substances consist of indol and its derivatives suggests itself. The probabilities in favor of this answer may be briefly stated as follows:

(1) Germs which produce indol and its derivatives are native and, so far as we know, constant representatives of the bacterial flora of the upper portion of the small intestines. There are many indol-forming germs, and while some of these may be present in any tissue, they are certainly present, in health and in disease, during life and after death, in the small intestines.

(2) Indol and its derivatives are products of anaërobic putrefaction, and this accounts for the fact that the reactions which we obtained are not familiar to those toxicologists who have experimented with tissue allowed to putrefy in the presence of oxygen. The apparatus which we used in our experimental work is practically the same as that employed by E. and H. Salkowski ("Zeitschrift f. physiologische Chemie," B. 8, S. 462) in the preparation of indol. Moreover, in the preparation of indol the same peculiarity in the evolution of gas is observed as in our work.

It was on account of our belief that indol and its derivatives had been in some instances mistaken for morphine that we were led to add these substances to C in our experiment.

We have obtained several samples of indol and skatol, and have compared the reactions obtained with these on the application of the color tests for morphine.

The samples of indol may be briefly described as follows:

No. 1.—Prepared by myself from decomposing pancreas. It is a brown, granular substance, and is probably not chemically pure. This fact, however, does not unfit this sample for experiments on the point under consideration, because any impurities which it may contain originated in the decomposing tissue, and may be present in the same substance obtained from like tissue.

No. 2.—Obtained from Merck. The order was simply for "indol," without any specifications whether it should be synthetic or putrefactive. It is brownish red in color.

No. 3.—Obtained from Schuchardt and ordered as synthetic indol, which it undoubtedly is. This sample is white and in flakes.

No. 4.—Obtained from Kahlbaum. Putrefactive indol was ordered, but the label is simply "indol." This sample consists of white flakes.

These samples were submitted to the following tests:

Reagent.	*No. 1.*	*No. 2.*	*No. 3.*	*No. 4.*	*Pure Morphine Sulphate.*
Nitric acid	Bluish black with violet border.	Reddish brown.	Reddish brown.	Reddish brown.	Brownish red, passing into lemon yellow.
Sulphuric acid	Yellowish green.	Brown.	Greenish yellow.	Brownish red.	Faint yellow.
Sulphuric with nitric acid	Same as with nitric acid alone.				Brownish red.
Ferric chloride	No change at first, but all become greenish blue.				Blue.
Iodic acid	No reduction.				Reduced.
Frohde's reagent	Reddish, then dark blue.	Reddish, then greenish blue.	Reddish, then greenish blue.	Reddish, then greenish blue.	Purple, then blue.

Two samples of skatol (No. 1 from Schuchardt and No. 2 from Kahlbaum) were compared with morphine with the following results:

Reagent.	*No. 1.*	*No. 2.*	*Morphine Sulphate.*
Nitric acid	All become lemon yellow.		
Sulphuric acid	All become very faintly yellow.		
Sulphuric with nitric acid	All become more of a red than with nitric acid alone.		
Ferric chloride	No change.	No change.	Blue.
Fröhde's reagent	Green to blue.	Green to blue.	Purple to blue.
Iodic acid	All promptly reduce the acid.		

While it would be comparatively easy to distinguish pure morphine from either indol or skatol, it must be admitted, from the results of the experiments already detailed, that the separation of morphine from tissue, decomposing in the absence of oxygen, and its identification, are

by the methods now generally employed, so uncertain that the conscientious chemist will seek for methods free from these sources of error before he gives positive testimony of the presence of this alkaloid.

I have spoken of indol and its derivatives as being present in the decomposing tissue, and it should be stated that the number of known indol derivatives is by no means small, and how many others there may be which remain unknown, no one can tell. Many of these substances give brilliant color reactions. Indol was first obtained by Bayer by the reduction of indigo. Later, Kühne and Nencki independently obtained indol with skatol by the putrefaction of albuminous substances.

There has been some difference of opinion as to the identity of the indol obtained by putrefaction and that which results from the reduction of indigo. According to Baumann neither indol nor skatol originates directly from the proteids, but both arise from the decomposition of a substance soluble in ether containing alcohol. Skatol is methyl indol.

Indoxyl is an easily decomposable substance, which gives some striking color reactions, among which may be mentioned the production of indigo-blue with ferric chloride in the presence of free hydrochloric acid. Skatol-carbonic acid is another product of putrefaction, E. and H. Salkowski having obtained 1.3 grams from 2 kilograms of moist fibrin after twenty-six days' putrefaction. Among the known color reactions of this substance, Hoppe-Seyler mentions the following:

(1) If a dilute solution of this acid (1–1000) be treated with a few drops of pure hydrochloric acid of 1.2 specific gravity, and then with a few drops of potassium nitrate solution (2 percent.), a cherry-red coloration is produced, and later a red precipitate falls.

(2) If such a solution be mixed with an equal volume of hydrochloric acid, and then a few drops of chloride of lime solution ($\frac{1}{2}$ percent.) be added, a purple-red color is produced.

(3) Treated with a few drops of hydrochloric acid, then with two or three drops of a very dilute solution of ferric chloride, and heated, the mixture becomes intensely violet before boiling.

Skatol-carbonic acid is non-volatile.

Skatol-acetic acid has been obtained by Nencki by the anaërobic putrefaction of serum-albumin. The aqueous solutions of this substance give with ferric chloride a white cloudiness, which on warming becomes brick-red, and in more concentrated solution fire-red.

Both indirubin and indigo-blue may be formed by the oxidation of indol.

Knowing now that indol and its derivatives are formed in anaërobic putrefaction, and that in Dragendorff's scheme for the separation and identification of vegetable alkaloids these substances appear in the residues which are tested for morphine, and knowing the great number and variety of color reactions given by these substances, it may be asked how much reliance can be placed on the color tests for morphine?

Besides the indol bodies, certain other substances are formed in the anaërobic putrefaction of proteid substances. Among these are certain aromatic products of the putrefaction of tyrosine. The following may be mentioned:

(1) Hydroparacumaric acid (para-oxyphenyl-propionic acid). This substance gives with ferric chloride a distinct, but evanescent, blue coloration.

(2) Para-oxyphenyl-acetic acid. This substance gives with ferric chloride a pale grayish-violet, which soon changes to a dirty green color.

Among other products of the anaërobic putrefaction of proteids phenol and parakresol may be mentioned.

Phenol gives with ferric chloride a violet color.

Parakresol gives with ferric chloride a blue coloration.

With the above-mentioned substances in a decomposing liver, and knowing that some of them at least are present in the amylic alcohol residue, following the process of Dragendorff, how much reliance, may again be asked, can be placed on the color reactions of morphine? The conscientious chemist who swears that he will tell the truth, the whole truth, and nothing but the truth, may answer this question.

POISONS FORMED IN DECOMPOSING TISSUE IN THE PRESENCE OF ARSENIC.

It has already been shown that the presence of arsenic does not interrupt the anaërobic putrefaction by which those substances interfering with the reactions for morphine are formed. Besides this, it is known that certain highly poisonous substances may be obtained from the bodies of persons who have been embalmed with arsenic. From one arsenical body which had been buried for fourteen days, Selmi obtained, by extracting with ether the fluid rendered alkaline with baryta, a substance which formed in needles and which gave crystalline salts with acids. With sulphuric acid it gave a red color; with iodic acid and sulphuric acid it liberated free iodine, and gave a violet coloration; with nitric acid it gave a beautiful yellow, which deepened on the addition of caustic potash. This cadaver was apparently well preserved, and the crystalline substance obtained from it was found to be highly poisonous. From a second arsenical body Selmi obtained by the same process a larger quantity of a most virulent poison.

From the stomach of a hog which had been preserved in a solution of arsenious acid, the same investigator separated an arsenical organic base. This substance produced symptoms like those of strychnia. Also from the same stomach he obtained a substance which produced in frogs torpor and paralysis.

These researches throw some light upon a most interesting and curious point in the history of toxicology. It is well known that during a certain period of Italian history poisons were freely used. One of these was sold under the name of *aqua toffana*, while another was known as *acquetta di Perugia*. Probably many other similar solutions were sold to those who desired to rid themselves of friends or foes. There seems to have been some diversity in the method of preparation used by those engaged in supplying these poisons. Duclaux states that one of these solutions was prepared by eviscerating a pig, powdering the abdominal cavity with arsenic, suspending the animal, and catching the drippings from the decomposing tissue. Kobert states that another preparation was obtained by preserving the saliva of animals poisoned with arsenic, and allowing this fluid to undergo putrefactive changes. It will be seen that by either of these methods powerful arsenical ptomaïnes may have been obtained. It will also be evident that these solutions may have owed their powerful action to the presence of toxicogenic germs, or, in other words, death may have been due to inoculation rather than to intoxication.

As has been stated in giving the experimental results obtained in the tests for morphine, anaërobic germs producing considerable quantities of gas were found in the liver. Another interesting point, which needs further study, was observed. Some of the putrefactive fluid resulting from the decomposition of the chopped liver contained a considerable amount of arsenic. This fluid was placed in a bottle and kept in the laboratory for six months. During this time the bottle was frequently opened. Whenever this was done a large amount of gas escaped with almost explosive rapidity. After the above-mentioned time it was decided to estimate the amount of arsenic in the fluid. Upon attempting to do this, it was unexpectedly found that the fluid contained not the slightest trace of arsenic. In other words, the arsenic had been given off from the fluid in the form of a gas. It was supposed at first that this was a new discovery; but upon looking the matter up it was found that Hünefeld, in the early part of the present century, found that tissues impregnated with arsenic gave off during putrefaction a garlic odor, and that later arsenic disappeared wholly from such tissue. This is an interesting fact, and one which needs further study.

POISONS FORMED DURING PUTREFACTION.

Methylguanidine.—This base, which has been found by Brieger and Bocklisch in decomposing flesh, is highly poisonous. The symptoms are marked by dyspnœa, muscular tremor, and general clonic convulsions. Two tenths of a gram administered to a guinea-pig produced the following symptoms: the respiration at once became rapid, and in a few minutes there were abundant evacuations of the bladder and bowels; the pupils rapidly dilated to the maximum, and then ceased to react; the animal became motionless, though not paralyzed; dyspnœa set in, and the animal died in convulsions twenty minutes after the administration of the poison. Post-mortem examination showed the heart to be arrested in diastole, the intestines filled with fluid, the bladder contracted, the cortex of the kidney hyperæmic, but the papillæ of the kidneys were surprisingly pale.

Tetanine, tetanotoxine, spasmotoxine, and *tetanus toxalbumins* have been found in cultures of the tetanus bacillus. These substances produce violent clonic and tonic convulsions.

Patoammine.—Selmi obtained this substance from the urine of patients suffering from progressive paralysis, also of those with interstitial pneumonia. The substance produces convulsions, and probably consists of a mixture of bases.

Isoamylamine has been found in yeast which has undergone putrefactive changes. It is a colorless, strongly alkaline liquid, possessing a marked but not disagreeable odor. It is a highly energetic poison, producing rigor, convulsions, and death. Four milligrams caused the death of a greenfinch in three minutes.

Ethylendiamin has been found in a cancerous stomach. It produces uninterrupted convulsions.

Ethylidendiamin.—This substance was obtained from putrid fish by Brieger, and was found to induce dyspnœa and dilatation of the pupils.

Trimethylendiamin.—This substance is present in cultures of the comma bacillus. It produces convulsions.

In the urine of men with epilepsy Férré found a substance which produces convulsions similar to those of strychnia. From like urine Griffiths has isolated a base.

With the germs obtained from the bodies of women dead with puerperal eclampsia, Gerdes has obtained a highly poisonous substance which produces convulsions.

Tyrotoxicon.—This substance, first obtained by the writer in poisonous cheese, and subsequently in poisonous ice-cream, milk, and certain milk products, is a highly active poison. Small doses cause in kittens retching, vomiting, and purging. Similar doses in man produce like symptoms, together with marked constriction of the fauces. Fatal doses in man cause dilatation of the pupils, rapid breathing, hurried pulse, and depression of temperature.

Mytilotoxine.—This substance, found in poisonous mussels, produces paralysis, resembling curare in its action.

Fugin, found in the roe, liver, stomach, and intestines of certain fish, has a curare-like action.

Ptomo-muscarines are frequently found in decomposing matter.

Neurine, found in decomposing tissue after five or six days, also has an action similar to that of curare.

According to Lustgarten, there is found in the dead skin resulting from severe burns a substance which produces symptoms similar to those of muscarine.

Adamkiewicz has obtained a substance which he believes to be the active agent in the production of cancer, and to which he has given the name of *cancroin*. He also proposes that this agent be used in the treatment of cancer, following the theory employed by Koch in the treatment of consumption. The substance is probably identical with neurine.

Susotoxine, a base isolated by Novy from cultures of the hog cholera bacillus, first retards, then increases, and finally again retards, respiration. Convulsive tremors occur at frequent intervals. A hundred milligrams produced death in a young rat, when given subcutaneously, in an hour and a half.

Cholin, found frequently in decomposing tissue, produces muscarine-like symptoms. It must be given, however, in large doses in order to produce poisonous effects. Brieger found that the fatal dose for a rabbit weighing one kilogram is about half a gram.

Mydatoxine was first obtained by Brieger from putrid human viscera. It produces paroxsymal convulsions, diarrhœa, and dyspnœa.

Gadinine, which may be present in human fæces, is mildly poisonous, requiring from one half to one gram to kill a guinea-pig.

Typhotoxine is produced by the Eberth germ of typhoid fever. Its action has been studied only on mice and guinea-pigs. It produces at first slight salivation with increased respiration. The animals lose control over the muscles of the trunk and extremities, and fall down helpless upon their sides. The pupils become strongly dilated and cease to react to light. Death follows in from one to two days.

Mydaleine is present in putrefying cadaveric organs, such as the liver and spleen. It has the peculiar property, when injected subcutaneously, of causing a marked rise in temperature, sometimes as much as two degrees.

THE MEDICAL JURISPRUDENCE OF LIFE INSURANCE.

BY

BRANDRETH SYMONDS, A.M., M.D.

History.—The growth of life insurance during the past hundred years is one of the most striking features of the period. The amounts invested have become enormous; the amounts which the companies have contracted to pay to their policy-holders are stupendous. On the 1st of January, 1893, there were sixty life insurance companies organized under the laws of the different States. The total assets of these companies amounted to over $919,000,000. The insurance which they had in force reached the gigantic total of over $4,897,000,000. This is greater than the debt of any country in the world. The mind cannot grasp the magnitude of the operations involved in the handling of this colossal *trust-fund*. For in nearly all the companies which are mutual, or which share their profits largely with the policy-holders, these assets can be regarded only as a fund, set aside by the policy-holders, intrusted to the care of the companies, returnable to the policy-holders at the end of a given time, or to their heirs in the event of their prior death. It is therefore very much to the interest of the policy-holders that the companies be well managed in all respects. That they have been so in the past is well shown by the rapid progress life insurance has made in the last thirty years. During that time the life insurance companies reporting to the department of the State of New York have increased their assets from $37,000,000 to $903,000,000; the amount of insurance in force has increased from $183,000,000 to $4,199,000,000. While the United States has been the seat of the greatest expansion of life insurance, other countries have to some extent shared in its growth. In fact, the whole civilized world has participated; but this is especially true of Great Britain and her colonies.

The Anglo-Saxon race can claim the credit both of originating life insurance and of carrying it to its present magnificent proportions. We are told by Francis (*Annals and Anecdotes of Life Insurance*) that mutual insurance associations were known in Great Britain soon after the Conquest. "The necessity of providing for casualties by mutual assistance —in other words, insurance on its broadest and most rational basis—was practiced in the Saxon guild, the origin of which was very simple. Every freeman of fourteen being bound to find sureties to keep the peace, certain neighbors, composed of ten families, became bound for one another, either to produce any one of the number who should offend against the Norman law, or to make pecuniary satisfaction for the offense. To do

this they raised a fund by mutual payments, which they placed in one common stock. This was pure mutual assurance." Further on he gives extracts from the by-laws of these ancient friendly societies. Thus:

"4. If any one take away the life of a member, his reparatory fine shall not exceed eight pounds; but if he obstinately refuse to make reparation, then shall he be prosecuted by and at the expense of the whole society; and if any individual undertake the prosecution, then each of the rest shall bear an equal share of the expense. If, however, a member who is poor kill any one, and compensation must be made, then, if the deceased was worth twelve hundred shillings, each member shall contribute half a mark; but if the deceased was a hind, each member shall contribute two oræ; if a Welchman, only one."

"7. If a member, being at a distance from home, shall die or fall sick, his fellow-members shall send to fetch him, either alive or dead, to whatever place he may have wished, or be liable to the stated penalty; but if a member shall die at home, every member who shall not go to fetch his corpse, and every member who shall absent himself from his obsequies, shall forfeit a sextarius of honey."

Among the rules of St. Catherine's Guild he gives the following:

"If a member suffer from fire, water, robbery, or other calamity, the guild is to lend him a sum of money without interest. If sick, or infirm through old age, he is to be supported by his guild according to his condition. If a member falls into bad courses, he is first to be admonished, and if found to be incorrigible he is to be expelled. Those who die poor, and cannot afford themselves burial, are to be buried at the charge of the guild."

These were very humble beginnings, and it was long before there were any further developments. Other varieties of insurance, especially marine, grew slowly into favor. It was all done by individual underwriters; the rates were high and the term was short. There was insurance effected at that time for ransoming sailors and pilgrims in case of capture by Turks, but there were no data upon which to make scientific life calculations. The census was faulty, and the mortality register did not contain the ages of the dead.

In 1693 Halley published the first table which showed the probabilities of living, at every age. This was founded on the death-registers of Breslau in Silesia, as that was the only place where the ages of the dead were recorded. Even this was not used for many years.

A few years prior to this, Graunt made some very shrewd guesses as to the expectation of life, which were founded on the London bills of mortality. As these bills did not give the ages of the dead, we can attach no scientific value to the results. The causes of death stated in these bills of mortality are very quaint, and indicative of the state of medicine at that time. Who would recognize croup as "the rising of the lights"? The resemblance of hydrocephalus to "horseshoe head" is a little closer when it is remembered how this disease separates the bones of the head and makes the coronal suture look a little like a horseshoe.

Long before this, in the beginning of the third century, Ulpianus constructed a table of the expectation of life for the calculation of annuities under the Falcidian law of inheritance. We do not know upon what these tables were founded, for the census, which was taken by the Romans every five years, did not in itself furnish sufficient data. The number of births

and deaths and the ages at death must be known also, and we are reasonably sure that the Romans made no record of these. The tables of Ulpianus compare favorably with some of the earlier English tables, but with improved methods of calculation and a greater extent of data the more recent tables show a much greater average longevity. On the other hand, it is quite possible that human life has lengthened its days since those times. Many students in this subject have come to this conclusion.

Toward the end of the eighteenth century Dr. Price constructed three mortality tables, the Northampton, the Chester, and the Swedish National tables. Of these three the Northampton is by far the least accurate, owing to a curious cause which was not appreciated by Dr. Price. In the town of Northampton there were a large number of Baptists who did not believe in infant baptism. In that way the ratio of births to the christenings was reduced to such an extent that the population of the town was thought to be stationary, whereas in reality it was constantly increasing. Hence the table made the average lifetime in the town to be six years less than we can reasonably suppose it was then, and thirteen less than it is now. Unfortunately, this table was the one which many insurance companies adopted, probably for the very reason that it was more favorable to them and discriminated against the policy-holder. Of late years it has been entirely dropped by insurance companies, who now depend chiefly upon tables constructed from the combined mortality experience of several companies.

The most elaborate work in this line is the English Life Tables constructed by Dr. Farr. These are three in number. The first is founded on the census of 1841 and the death records for that year. The second is based on the same census, but includes the death records for three preceding and three subsequent years. The English Life Table No. III. includes also the census of 1851 and the death records for seventeen years. From the same data Dr. Farr has constructed a table of Healthy Lives, using for this purpose only those districts in which the mortality was seventeen or less per mille per annum. To give some idea of the enormous labor involved in these computations, it is stated that the ages of over fifty million living persons and of over six million deaths enter into the calculations.

The first life insurance policy of which we have legal record is dated June 18, 1583. It was on the life of William Gibbons, for twelve months from that date. It was underwritten by a number of individuals at the enormous rate of eight pounds percent. The insured died on May 29, 1584, and payment was resisted on the ground that the twelve months referred to were lunar months of twenty-eight days. This was promptly overruled in the courts. Prior to this there was insurance for ransoming sea-captains and pilgrims, and very probably on ordinary lives. Annuities certainly were granted to individuals before this, but the rates were enormous. The highest expectation of life at this time was held to be seven years, and it was considered to be the same for all ages. The profits of the insurer under these circumstances were very great, and amounted to the grossest usury.

In 1699 the earliest project for mutual life insurance was devised. It was called "The Society of Assurance for Widows and Orphans." In many respects it resembled quite closely some of the modern assessment associations. There was an entrance fee of five shillings, and an assess-

ment of five shillings more on the death of each member. This would have given five hundred pounds when the full membership of two thousand was obtained. The applicant had to furnish a certificate of his age, and also had to make affidavit that he knew of no illness which afflicted him, and that he was in a good state of health. He had to appear in person before the trustees, and might be rejected by them. As there was no medical examination, death within six months after issuing the policy did not avail. There were clauses providing for the forfeiture of the policy in case of death by the hands of justice. Military, naval, and seafaring risks were excluded, and in case of members dying in violation of any of these provisos, the policy was forfeited. Forfeiture also occurred in case the subscriber did not pay his assessment within seven days after notice. This scheme was certainly very ingenious, and ought to have given satisfaction; but, like most of these plans, the death-rate probably increased in a few years, the assessments rolled up and became too numerous. It lived but a few years, and, so far as we know, died a natural death about 1711.

In 1706 a charter was granted to the "Amicable Society for a Perpetual Assurance Office." This is the first life insurance company of which we have any very definite information, and which sustained the strain of early years. It was a purely mutual company; the rates were very high, and were the same for all ages between twelve and forty-five. They did not accept risks outside those ages. The annual income after deducting expenses was divided yearly among the representatives of those who had died during the past year. This was of course a most inequable arrangement. In some years the mortality was light, and the individual return was proportionally large; but the next year it might be just the reverse. This was modified in later years, but not very successfully. The inherent faults of the scheme were too great, and the old Amicable finally succumbed in 1866, after an existence of one hundred and sixty years. It was then absorbed by the Norwich Union Life. It is sometimes said that the Hand-in-Hand and the Sun offices were founded before the Amicable. This is true, but they both started out as fire insurance companies, and did no life business until many years after the Amicable had been established.

It may be amusing to note some of the other features of this period. It was a time when gambling was rife in all classes of society, and the South Sea Bubble was swelling. There was a company for suppressing thieves and robbers and for insuring all persons and goods from the same; a company for insuring against losses they shall sustain by servants, thefts, etc.; an insurance company for horses dying natural deaths, stolen, or disabled; for assurance of female chastity; insurance from house-breakers; insurance from highwaymen; insurance from lying; insurance from death from drinking geneva; rum insurance. The foregoing is a very imperfect list of these schemes, which amounted to nothing in the end. Real life insurance had to go through a feeble infancy and an overfed childhood before it reached its present vigorous youth.

In 1720 two proprietary companies were started, the Royal Exchange and the London Assurance. These first confined their attentions exclusively to fire and marine insurance, but in 1721 their charters were amended so as to permit them to write risks on lives. They did a small business, at heavy rates, and nearly all of it was for short terms of a

year or less. Few people could afford the luxury longer, when it cost £5 5s. per year for £100 of insurance. Some years later Thomas Simpson showed that on the basis of Halley's Breslau table it was possible to construct a table of life expectation for every age, and soon after James Dodson actually did this. These results attracted much attention. Finally a number of gentlemen formed themselves into a purely mutual life insurance company, which still survives in England under its original title of "The Equitable Society for the Assurance of Life and Survivorship." They endeavored to obtain a charter from Parliament, but this was frustrated through the objections of the Royal Exchange and the London Assurance. The Royal Exchange stated with ingenuous simplicity that it was a very poor business and that the expenses ate up all the profits. But as the new company required no capital, being purely mutual, they overcame this by drawing up a deed of settlement, which was finally enrolled in 1765, three years after the first policy had been issued. At first the outcome was very doubtful, and Francis says that, in order to give an appearance of strength and age to the delicate infant, they called the twenty-fifth policy the two hundred and seventy-fifth. The premiums were at first fifty percent. to one hundred percent. higher than those charged at present; but by the end of the century they had been very much reduced. The "Old Equitable" is still alive and flourishing, although in a very conservative way. To it we must bow as being the first real representative of modern life insurance.

While life insurance was fostered and encouraged in England by law and custom, the reverse was the case on the Continent. In the end of the seventeenth and the beginning of the eighteenth century, ordinances forbidding the insurance of lives of persons were issued in the Netherlands, in Genoa, Amsterdam, and Rotterdam, and in 1681 Louis XIV. issued a similar one in France. The result has been that life insurance rather languished throughout the rest of Europe until within late years. But now it has become a fixed institution there, and a great volume of life insurance is written in most of Europe, a considerable part of which is done by American companies.

It is necessary to say a word about the tontine plan, which has been revived in a very modified form. This owes its name to Lorenzo Tonti, who lived during the seventeenth century. His original plan was as follows: A certain number of persons clubbed together a specified sum (without reference to age or sex), and at the expiration of each year the interest of this fund was divided among the subscribers who were living, and so on from year to year, until the last survivor received the whole of the interest. After the death of the last survivor the principal reverted to the founders of the scheme, i.e., the State, for their own use. This termination sufficed to kill the original plan, and it was soon altered so that the entire original sum was received by the last surviving member. Even on this basis it was too great a speculation, and never had much popular support. The results that were obtained in some of these tontines were almost fabulous. One was started in 1689, the subscription being 300 livres. The last survivor of this, in 1726, was a widow of ninety-six years of age, and she received an income from it of 73,500 livres.

At the present time all purely tontine methods in life insurance have been dropped. There are, however, methods by which the insured allows all his profits from early lapses, compound interest, etc., to accumulate

for a number of years, usually ten, fifteen, or twenty, and then receives the whole of it in one dividend. This is more befitting than the usual yearly dividend in many respects, for it tends to equalize the inequalities which affect that system by reason of a heavy mortality one year and a light one the next. The so-called semi-tontine system is the one adopted by a large proportion of insurers in this country.

LEGAL.

Before entering upon the discussion of the medico-legal features of this question, it is necessary to elaborate a little some of the purely legal points. This must be done very briefly, and only things of importance can be touched upon. Any extended discussion would be quite unbecoming on the part of the writer.

A contract of insurance has been defined as "an agreement by which one party, for a consideration (which is usually paid in money, either in one sum or at different times during the continuance of the risk), promises to make a certain payment of money upon the destruction or injury of something in which the other party has an interest." (*Commonwealth* vs. *Wetherbee*, 105 Mass. 149, 160.) This definition has been adopted in many cases of life insurance, and can be considered as generally accepted. Courts have erred at times in regarding this contract as governed by different rules from ordinary contracts, but it is now usually held that the same principles apply to it as to other agreements involving pecuniary obligations. There is this difference, however, that in the case of any ambiguity in the contract of insurance, the construction most unfavorable to the insurer will be adopted. This is right, for it happens that the insurer is the one that makes up the printed contract used in nearly all cases. Hence, since it is his language which is used, it should be turned against him if it is at all doubtful in its meaning. There are three parties to these contracts: the insurer, who nowadays is practically always a company or association; the insured, who is the person applying and examined; and the beneficiary, who is the person to whom, or to whose legal representatives, the amount due at the death of the insured is to be paid. It is of course possible for the insured to be also the beneficiary.

Insurance corporations may be divided into three classes, stock, mutual, and mixed. The first has for its basis a capital stock. It ordinarily issues policies at lower premium rates than the others. None of its profits are divided among the policy-holders, but all go to the stockholders. In mutual companies the insured themselves are the members of the company, and receive their share of the surplus premiums over and above those necessary for the payment of losses and expenses. In mixed companies a certain proportion of the profits is paid to the stockholders and the remainder distributed among the insured.

Warranties and Representations.—The applicant is required by most companies to warrant the truth of the statements made by him in his application for insurance. In the case of a warranty the validity of his policy depends upon the accuracy of his statements, and any falsity in them will prevent the liability of the insurer from taking effect. A warranty forms a part of the contract, and if not strictly complied with the whole contract is rendered void, even if the mistake is entirely immaterial and innocent. Furthermore, it makes no difference what the

object of the insurer was in asking the question, or even whether he had any object.

In some cases the statements of the applicant are not certified in such a manner as to constitute a warranty. They then become representations, and are divided into two classes, material and immaterial. The former are those on which the insurer relies in making his contract. "But in many cases where the language of the contract is regarded as insufficient to create a warranty, it is regarded as sufficient to create an agreement that a statement, of itself immaterial, is to be regarded as material; that is to say, as a material representation. This commonly happens in the case of an answer made to a specific inquiry made by the insurer, the fact of his asking it being regarded as sufficient to show that he regards the answer as a material representation, and the assent of the insured that it be so regarded is sufficiently shown by his making the answer." Material representations must be untrue in some material particular to avoid the contract. Their materiality does not depend upon their ultimate influence on the risk or their relation to the cause of loss. It depends upon the effect it has on the judgment of the party who assumes the risk at the time he assumes it. Even if the loss should occur from circumstances totally unconnected with the fact materially misrepresented, the policy is void. The insurer, had he known the true state of affairs, might then have declined the risk or charged a higher premium.

Many of these points are so carefully considered in the decision in the case of *Campbell* vs. *Life Insurance Co.*, 98 Mass. 381, that it is worth our while to quote somewhat extensively from it. "A warranty, in insurance, enters into and forms part of the contract itself. It defines, by way of particular stipulation, description, condition, or otherwise, the precise limits of the obligation which the insurers undertake to assume. No liability can arise except within those limits. In order to charge the insurers, therefore, every one of the terms which define their obligation must be satisfied by the facts which appear in proof. From the very nature of the case, the party seeking his indemnity, or payment under the contract, must bring his claim within the provision of the instrument he is undertaking to enforce. The burden of proof is upon the plaintiff to present a case in all respects conforming to the terms under which the risk was assumed. It must be not merely a substantial conformity, but exact and literal; not only in material particulars, but in those that are immaterial as well.

"A representation is, on the other hand, in its nature, no part of the contract of insurance. Its relation to the contract is usually described by the term 'collateral.' It may be proved, although existing only in parol and preceding the written instrument. Unlike other verbal negotiations, it is not merged in nor waived by the subsequent writing. This principle is peculiar in some respects to insurance, and rests upon other considerations than the rule which admits proof of verbal representations to impeach written contracts on the ground of fraud. Representations to insurers, before or at the time of making a contract, are a presentation of the elements upon which to estimate the risk proposed to be assumed. They are the basis of the contract; its foundation on the faith of which it is entered into. If wrongly presented, in any respect material to the risk, the policy that may be issued thereupon will not take effect. To enforce it would be to apply the insurance to a risk that was never pre-

sented. But when the insurer seeks to defeat a policy on this ground, his position in court is essentially different from that which he may hold upon a policy containing a like description of the risk as one of its terms. It is sufficient for the plaintiff to show fulfillment of all the conditions of recovery which are made such by the contract itself. The burden is then thrown upon the defendant to set forth and prove the collateral matters upon which he relies. . . .

"When statements or engagements on the part of the insured are inserted or referred to in the policy itself, it often becomes difficult to determine to which class they belong. If they appear on the face of the policy, they do not necessarily become warranties. Their character will depend on the form of expression used, the apparent purpose of the insertion, and sometimes upon the connection or relation to other parts of the instrument. If they are contained in a separate paper, referred to in such a manner as to make it a part of the contract, the same considerations of course will apply; but if the reference appears to be for a special purpose, and not with a view to import the separate paper into the policy as a part of the contract, the statements it contains will not thereby be changed from representations into warranties. It is perhaps needless to add that verbal representations can never be converted into warranties otherwise than by being afterward written into the policy.

"In considering the question whether a part of the contract is a warranty, it must be borne in mind, as an established maxim, that warranties are not to be created nor extended by construction. They must arise, if at all, from the fair interpretation and clear intendment of the words used by the parties. When, therefore, from the designation of such statements as 'statements' or as 'representations,' or from the form in which they are expressed, there appears to be no intention to give them the force and effect of warranties, they will not be so construed.

"The application is, in itself, collateral merely to the contract of insurance. Its statements, whether of facts or of agreements, belong to the class of representations. They are to be so construed, unless converted into warranties by force of a reference to them in the policy, and a clear purpose, manifested in the papers thus connected, that the whole shall form one entire contract. When the reference to the application is expressed to be for another purpose, or when no purpose is indicated to make it a part of the policy, it will not be so treated." In a later trial in the same case it was held (98 Mass. 402): "It is true that a representation need not, like a warranty, be strictly and literally complied with, but only substantially and in those particulars which are material to be disclosed to the insurers to enable them to determine whether they will enter into the contract; and that, where the question of the materiality of such particulars depends upon circumstances, and not upon the construction of any writing, it is a question of fact to be determined by the jury. But where the representations upon which the contract of insurance is based are in writing, their interpretation, like that of other written instruments, belongs to the court, and the parties may, by the frame and contents of the papers, either by putting representations as to the quality, history, or relations of the subject insured into the form of answers to specific questions, or by the mode of referring to them in the policy, settle for themselves that they shall be deemed material; and when they have done so, the applicant for insurance cannot afterward

be permitted to show that a fact which the parties have thus declared to be material to be truly stated to the insurers, was in fact immaterial, and thereby escape from the consequences of making a false answer to such a question."

In the case of *Price* vs. *Life Insurance Co.*, 17 Minn. 473, some excellent definitions are given in very simple and concise language. "So far as the questions presented by the case at bar are concerned, it is sufficient to define a warranty in insurance to be a part of the contract evidenced by the policy, and a binding agreement that the facts stated are strictly true. A representation in insurance may, for the purpose of this case, be defined to be a statement in regard to a material fact made by the applicant for insurance to the insurer with reference to a proposed contract of insurance. As representations simply, they are not a part of the contract of insurance. And though expressly referred to in the policy, so as to become a part of the written contract, they may not become warranties. And even if it be made by the very terms of the policy, as in the case at bar, an express condition of the contract of insurance that if such representations are found to be untrue the policy shall be null and void, they do not necessarily lose their character as representations and become warranties, though the effect of such express condition may be to make them conclusively material.

"It is sufficient if representations be substantially true, while a warranty must be strictly complied with. A false warranty, therefore, avoids a policy, while a false representation (not fraudulent) does not avoid a policy unless it relates to something which is material in fact, or is made material by the contract of the parties. Warranties, then, are conditions precedent, so that their truth must be pleaded by the assured, upon whom, of course, the burden of proving the same rests, whereas the falsity of representations is matter of defense to be pleaded by the insurer."

In both the preceding cases it is assumed that the burden of proving the truth of a warranty rests upon the insured. This is not the opinion usually held, and, as a rule, it may be said that the burden of proof of a breach of warranty rests upon the insurer. For, considering the number of warranties in any application, their positive proof would be out of the question on the part of the insured, and would throw an overwhelming task upon the beneficiaries of every policy.

In England, where the doctrine of warranties apparently originated, it is construed quite as strictly as in this country. In the case of *Anderson* vs. *Fitzgerald*, 4 H. L. 484, it was carried to the House of Lords and very thoroughly discussed. In this case the policy contained the proviso that "if any circumstance material to this insurance shall not have been truly stated, or shall have been misrepresented or concealed, or any false statements made to the company in or about the effecting of this insurance," the policy should be null and void. The applicant answered in the negative the questions, "Did any of the party's near relatives die of consumption or any other pulmonary complaint?" and "Has the party's life been accepted or refused at any office?" It was proven that his negative answers were both false. The House of Lords held that the proviso, above quoted, covered all statements, whether material or immaterial, whether false by design or through ignorance.

A similar decision was rendered by the Supreme Court of the United

States in the case of *Jeffries* vs. *Life Insurance Co.*, 22 Wall. 47. In the policy it was agreed that "the statements and declarations made in the application, and on the faith of which it is issued, are in all respects true, and without the suppression of any fact relating to the health or circumstances of the insured, affecting the interests of the company." The applicant stated that he was single, and that he had made no application to any other company. Both of these statements were proven to be false. It was held as follows: "It is contended, also, that the false answers in the present case were not to the injury of the company, that they presented the applicant's case in a less favorable light to himself than if he had answered truly. Thus to the inquiry, 'Are you married or single?' when he falsely answered that he was single he made himself a less eligible candidate for insurances than if he had truly stated that he was a married man; that, although he deceived the company and caused it to enter into a contract that it did not intend to make, it was deceived to its advantage, and made a more favorable bargain than was supposed.

"This is bad morality and bad law. None may do evil that good may come. No man is justified in the utterance of a falsehood. It is an equal offense in morals, whether committed for his own benefit or that of another. . . .

"The statements need not come up to the degree of warranties. They need not be representations even, if this term conveys the idea of an affirmation having any technical character. 'Statements and declarations' is the expression; what the applicant states and what the applicant declares. Nothing can be more simple. If he makes any statement in the application, it must be true. If he makes any declaration in the application, it must be true. The faithful performance of this agreement is made an express condition to the existence of a liability on the part of the company.

"There is no place for the argument that the false statement was not material to the risk, or that it was a positive advantage to the company to be deceived by it. It is the distinct agreement of the parties that the company shall not be deceived to its injury or to its benefit. The right of an individual or corporation to make an unwise bargain is as complete as that to make a wise bargain. The right to make contracts carries with it the right to determine what is prudent and wise, what is unwise and imprudent, and upon that point the judgment of the individual is subject to that of no other tribunal. The case in hand affords a good illustration of this principle. The company deems it wise and prudent that the applicant shall inform it truly whether he has made any other application to have his life insured. So material does it deem this information that it stipulates that its liability shall depend upon the truth of the answer. The same is true of its inquiry whether the party is married or single. The company fixes this estimate of its importance. The applicant agrees that it is thus important by accepting the test. It would be a violation of the legal rights of the company to take from it its acknowledged power thus to make its opinion the standard of what is material, and to leave that point to the determination of the jury."

While the language of insurance contracts has been made more and more stringent, the tendency of both judge and jury has been toward a very liberal construction of them, with all the odds in favor of the insured. They seize upon the slightest turn or twist of phraseology which

will enable them to convert a sentence apparently intended for a warranty into a representation. They say, with much truth, that these contracts are drawn up by the insurer and the language used in them is carefully considered beforehand. If there is the slightest ambiguity anywhere, it must be construed to the benefit of the insured, who usually signs the application without noticing the printed declarations on it. He knows that he will not have to pay anything until he gets the policy, and when he reads that he is not apt to observe that the application is made a part of it. This liberal tendency of the courts is well brought out in the following case of *Clapp* vs. *Massachusetts Benefit Association*, 146 Mass. 519:

"The seven rulings requested by the defendant are based upon the theory that it was entitled to a verdict if the answers of Clapp in reference to such matters were in fact untrue, although made honestly and in good faith. Whether it was so entitled or not must depend upon the construction to be given to the acknowledgment or certificate which was subscribed by the deceased as part of the application, and which from its language must be held to have controlled and governed the answers to which it referred.

"This acknowledgment, as it is termed, is as follows: 'I, Edward A. Clapp, of West Manchester, county of Essex, State of Massachusetts, do hereby warrant each and all of the foregoing particulars and statements to be true to the best of my knowledge and belief, and that I have not, in this application for above-named contract, concealed or withheld any material circumstance or information concerning the past or present state of my health or habits of life; and I do hereby acknowledge, consent, and agree that any untrue or fraudulent statement made above, by me or any one else, or to any medical examiner of said Massachusetts Benefit Association, or any concealment of facts by me or any one else, may forfeit and cancel all rights to any benefit under the above-named contract.'

". . . Undoubtedly the acknowledgment may grammatically be separated into two parts: the first a warranty that the statements made are true according to the best of the applicant's knowledge and belief, and the second an agreement that any untrue or fraudulent statement may forfeit the contract. But, if susceptible of such a grammatical construction, it can hardly have been intended that it should have been thus understood. Nor would it be a natural construction, and one that would suggest itself to an applicant. He would not suppose that, while he was only required to warrant that his answers were true according to his 'knowledge and belief,' his certificate or policy was to be forfeited if an answer honestly made should prove in fact untrue. The language used in the form of acknowledgment does not suggest any idea so much in the nature of a contradiction as this.

"These forms are prepared by the insurer with great care and great minuteness of detail. They are often signed in comparative haste; and if the association had intended to impose a forfeiture of his certificate upon the applicant because of an untrue statement, while it had only required him to warrant that his statements were true to the best of his knowledge and belief, a contract so anomalous should have been clearly expressed. It must be presumed that the defendant prepared its forms of application and certificate with the intention both of protecting itself against fraud and of securing the just rights of the assured under a valid

contract. It is reasonable that its words should be construed against itself, rather than in such a manner that one dealing with it should by any ambiguity be deceived as to his rights.

"The defendant urges that the words 'untrue or fraudulent,' used in the disjunctive, and thus expressing different states of things, show that by the use of the first word it was intended that the policy should be avoided if any material thing was untrue, although stated without fraudulent intent. The connection in which the word is used shows otherwise. In following the earlier clause, it means a statement which is untrue in opposition to the sense in which it has been promised that it shall be true. Again, while in strictness a statement is untrue which is not in precise conformity with the facts, yet in a more general sense the word 'true' is often used as a synonym of honest or sincere, without evasion or fraud. Such is the sense in which it is used in the acknowledgment. . . .

"The case was presented by the defendant on the theory that it was entitled to a verdict if Clapp's answers were shown in any material respect to be untrue. This was rejected by the presiding judge, who held that it must be shown also that such statements were known or believed to be untrue. . . . In each request for a ruling, the defendant omitted the element of Clapp's knowledge and belief. This was the point of conflict between its contention and the position taken by the presiding judge, who throughout his instructions insisted that not only must the answers of Clapp be proved untrue, but that they were so according to his knowledge and belief." The Supreme Court of Massachusetts held that the judge was right in giving these instructions, and overruled all the exceptions of the defendant.

These extracts are, I think, sufficient to show the distinctions between warranties, material representations, and immaterial representations. At the same time it must be repeated that the more recent decisions show, if not a favoritism, certainly a decided sympathy with the insured. Furthermore, even if the court holds that any given arrangement of words makes the statements of the applicant warranties, it is still within the province of the court to define what is warranted in most cases. Here a great deal of latitude is allowed. Thus the question, "Have you always been temperate?" has been held to refer to the habitual use of alcoholics, and hence an occasional intemperance was regarded as no falsification. One judge has even gone so far as to say that an attack of delirium tremens was not incompatible with an affirmative answer to this question.

Incomplete and Omitted Answers.—If there is no specific inquiry by the insurer as to any fact, the omission of the applicant to state it does not necessarily invalidate the policy, unless the omission was intentional, and the fact material in itself. This is right, for the insurers regularly ask all the questions which they think will have a bearing on the risk except those for which they rely upon their own independent means of information. When an answer to any question appears to be complete, although in reality it is incomplete, the omission will avoid the contract, if it is that of a material statement. Thus in the case of *Cazenove* vs. *Life Insurance Co.*, 3 Bigelow's Life and Acc. Cases 202, 213, it was held that "an answer may in one sense be said to be true, namely, if as much as it does state is not untrue, but it may nevertheless be sub-

stantially an untrue statement. I think that this answer is untrue; just as when a man is asked how old he is, and he says he is thirty, and as he is that, and something more than that, it may be said in a sense that the answer is true. However, in a case of this sort I think it is trifling to say that it is a true answer, if something more is to be added to make it true."

If, however, the question appears on its face to be answered imperfectly or not at all, and there are no further steps taken by the insurer to make the applicant complete the answer, this partial or entire omission does not avoid the contract. Here, too, the courts are very liberal in construing any ambiguity to the detriment of the insurer. Thus in the case of *Life Insurance Co.* vs. *Raddin*, 120 U. S. 183, the Supreme Court of the United States held as follows: "The twenty-eighth printed question in the application consists of four successive inquiries, as follows: 'Has any application been made to this or to any other company for assurance on the life of the party? If so, with what result? What amounts are now assured on the life of the party, and in what companies? If already assured in this company, state the number of the policy.' The only answer written opposite this question is '$10,000, Equitable Life Assurance Society.'

"The question being printed in very small type, the answer is written in a single line midway of the opposite space, evidently in order to prevent the ends of the letters from extending above or below that space; and its position with regard to that space, and to the several interrogatories in the question, does not appear to us to have any bearing upon the question and effect of the answer.

"But the four interrogatories, grouped together in one question, and all relating to the subject of other insurance, would naturally be understood as all tending to one object—the ascertaining of the amount of such insurance. The answer, in its form, is responsive not to the first and second interrogatories, but to the third interrogatory only, and fully and truly answers that interrogatory by stating the existing amount of prior insurance and in what company, and thus renders the fourth interrogatory irrelevant. If the insurers, after being thus truly and fully informed of the amount and place of the prior insurance, considered it material to know whether any unsuccessful applications had been made for additional insurance, they should either have repeated the first two interrogatories, or have put further questions. The legal effect of issuing a policy upon the answer as it stood was to waive their right of requiring further answers as to the particulars mentioned in the twenty-eighth question, to determine that it was immaterial for the purposes of their contract whether any unsuccessful applications had been made, and to estop them to set up the omission to disclose such applications as a ground for avoiding the policy. The insurers, having thus conclusively elected to treat that omission as immaterial, could not afterward make it material by proving that it was intentional."

This reasoning is certainly drawn out to a very fine point, and the decision seems hardly fair to the company. In the case of *Mutual Aid Society* vs. *White*, 100 Pa. St. 12, the ruling on a very similar condition of affairs was practically the reverse of this. There was one question arranged like this:

"(*a*) Are you married? ....

"(*b*) Give name of consort. Widdower."

It was proven that he had a wife living at the time of the application, from whom he was separated. The appellate court ruled that there was no ambiguity about the reply, as it was evidently responsive to both questions, and bad spelling is so common as not to count against the answer. It constituted a material misrepresentation, and therefore the judgment of the lower court was reversed.

Superfluous Answers.—The insured is not bound by immaterial statements made by himself which are not responsive to any question put by the insurer, even though his statements are held to be warranties. In the case of *Buell* vs. *Life Insurance Co.*, 5 Bigelow's Life and Acc. Cases 473, the question was asked: "Has father, mother, brother, or sister of the party died, or been afflicted with consumption, or any disease of the lungs, or insanity? If so, state full particulars of each case." The answer was: "No. Father died from exposure in water; age, fifty-eight." It was proven and admitted that the father had died before the age of thirty; but the court held that "the falsity complained of in the answer consists only in reference to the age at which the father died. This certainly was not inquired of in the question, unless we are to find it in that part of it which reads, 'If so, state full particulars in each case.' . . . I think the question fairly means, not whether the father, etc., had died from any disease, or from any cause, but whether he had died of, or been afflicted with, consumption, or any disease of the lungs, or insanity. This being the fair import of the question, 'No' was a complete answer to it, and the remainder of the answer was uncalled for and not responsive to the question. But suppose that be so; defendant claims that it is nevertheless an answer of some sort, and therefore an important part of the contract. The reply to that is that the declaration which relates to the answers to the questions to be made by the plaintiff, and which it was agreed should be made part of the contract, must be construed to, and does mean such answers as are responsive to the questions, and such as may be called for by the defendant, and that it does not cover such answers as may be volunteered and irrelevant, and that amount to mere representations. . . . The part of the answer in question in this case, in reference to the age of the father at death, being a mere representation, does not constitute a defense, unless it appears to have been material as well as false."

Beneficiary.—In the beginning of the last century it was the custom in England to effect insurance upon lives in which neither the insurer nor the insured had any interest. These policies were properly nothing but wagers. The amounts bet were very large, and the subjects often were very absurd. Thus as late as 1777 there were very large gambling assurances as to whether the so-called Chevalier d'Eon was a man or a woman. This extraordinary man had been sent to St. Petersburg on some confidential diplomatic mission, disguised as a woman. He retained the dress for some time after he returned to France. When he went to England he assumed that of a man, but it was there decided in an action before Lord Mansfield (*Da Costa* vs. *Jones*, Cowp. 729) that he was a woman. Soon after this he returned to France, but under the orders of the Court of Saint-Germain he was compelled to wear female garb. He did this until he died in 1810, when it was thoroughly established by post-mortem investigation that he was a man.

The practice of wager policies grew to such serious proportions that finally it was forbidden by an act of Parliament. (14 George III., c. 48.)

This enacted that "no insurance shall be made on the life of any person, or any event whatsoever, where the person on whose account such policy shall be made shall have no interest; or by gaming or wagering; and that every such insurance shall be null and void.

"It shall not be lawful to make any policy on the life of any person, or any other event, without inserting in the policy the name of the person interested therein, or for whose use or whose account such policy is so made.

"Where the insured has an interest in such life or event, no greater sum shall be received than the amount of the interest of the insured in such life or event."

This has been followed by similar statutes in this and other States. The doctrine that the beneficiary must have an insurable interest in the life of the person assured is rather an anomaly. It has been held that the lack of an insurable interest was contrary to public policy; but it is more than likely that this idea arose from the statutes bearing upon the subject. However, it must be considered as an established principle now and accepted until it is overruled. It is difficult to state just what constitutes an insurable interest. Two well-known definitions are as follows: "All which it seems necessary to show, in order to take the case out of the objection of being a wager policy, is, that the insured has some interest in the life of the *cestui que vie;* that his temporal affairs, his just hopes and well-grounded expectations of support, of patronage, and advantage in life will be impaired; so that the real purpose is not a wager, but to secure such advantages supposed to depend on the life of another. Perhaps it would be difficult to lay down any general rule as to the nature and amount of interest which the assured must have." (Chief-Justice Shaw, in *Loomis* vs. *Eagle Co.*, 6 Gray (Mass.) 396, 399.)

"It is not easy to define with precision what will in all cases constitute an insurable interest, so as to take the contract out of the class of wager policies. It may be stated generally, however, to be an interest, arising from the relations of the party obtaining the insurance, either as creditor of or surety for the assured, or from ties of blood or marriage to him, as will justify a reasonable expectation of advantage or benefit from the continuance of his life. It is not necessary that the expectation of advantage or benefit should always be capable of pecuniary estimation." (Justice Field, in *Warnock* vs. *Davies*, 104 U. S. 775.)

The distinctions drawn in the cases are sometimes very fine; but generally they tend to follow the above definitions. A wife has an insurable interest in the life of her husband (*Baker* vs. *Insurance Co.*, 43 N. Y. 283), and the validity of the policy will survive a divorce (*Insurance Co.* vs. *Schafer*, 94 U. S. 457). A husband has ordinarily an insurable interest in the life of his wife, and a father in that of his minor son; but not necessarily a son in the life of his father, nor a nephew in the life of his uncle; but a sister can be the beneficiary of her brother. (*Insurance Co.* vs. *France*, 94 U. S. 561.)

A creditor has an insurable interest in the life of a debtor. If a policy is taken out in good faith and assigned to a creditor, it has been held that it still remained valid even if the insurable interest of the assignee ceased to exist. Thus in the case of *Olmstead* vs. *Keyes*, 85 N. Y. 593, it was held that: "The rule, as gathered from these authorities, is that where one takes out a policy upon his own life as an honest and

bona fide transaction, and the amount insured is made payable to a person having no interest in his life, or where such a policy is assigned to one having no interest in the life, the beneficiary in the one case and the assignee in the other may hold and enforce the policy if it was valid in its inception, and the policy was not procured or the assignment made as a contrivance to circumvent the law against betting, gaming, and wagering policies."

On the other hand, it has been held that a creditor has no interest in the policy beyond the amount of his claim. This was the view taken in the case of *Cammack* vs. *Lewis*, 15 Wall. 643. The same court on the case of *Warnock* vs. *Davies*, 104 U. S. 775, held that: "If there be any sound reason for holding a policy invalid when taken out by a party who has no interest in the life of the assured, it is difficult to see why that reason is not as cogent and operative against a party taking the assignment of a policy upon the life of a person in which he has no interest. The same ground which invalidates the one should invalidate the other, so far at least as to restrict the right of the assignee to the sums actually advanced by him."

In May on insurance, vol. i., p. 199, the opinion is given that: "Upon the whole, it is not improbable that, when the point is distinctly taken, it will be held that when the contract, at its inception, is based upon a substantial interest, and in good faith is entered into for the protection of that interest, it is not objectionable as a wager contract, and may be enforced though the interest may have ceased at the time of the death. And this the more probable, as while such a rule will keep the door shut against mere gambling and speculation, it will tend to encourage what is now almost universally regarded as a provident contract, securing not only an indemnity in case of loss, but the means of presently increasing capital, and a not disadvantageous mode of investment."

One of the most extraordinary cases in which the question of a beneficiary entered occurred a few years ago. Toward the end of 1877 Benjamin Hunter took out $10,000 in one company and large amounts in two others on the life of John Armstrong. A few weeks later, while Armstrong was going home one night, he was attacked by some one in the streets of Camden, N. J., and received several blows on the head, from the effects of which he died two days later. No motive could be assigned for the crime until the existence of these policies was found out. Then Hunter was suspected, arrested, and finally convicted of murder in the first degree, for which he was hanged. Between the time of his conviction and execution he assigned the policies over to the widow of Armstrong. She of course received them subject to all the equities between the original parties. Suit was then brought against the insurers, and a verdict was given in her favor. On appeal it was held (117 U. S. 597, 598) that: "The theory of the defense is, that the purpose of Hunter in obtaining the insurance was to cheat and defraud the company. In support of that position, evidence that he effected insurance upon the life of Armstrong in other companies at or about the same time, for a like fraudulent purpose, was admissible. A repetition of acts of the same character naturally indicates the same purpose in all of them; and if, when considered together, they cannot be reasonably explained without ascribing a particular motive to the perpetrator, such motive will be considered as prompting each act. A creditor has an insurable interest in

the life of his debtor, and may very properly procure an insurance upon it for an amount sufficient to secure his debt; but if he takes out policies in different companies at or near the same time, and thus increases the insurance far beyond any reasonable security for the debt, an inquiry at once arises as to his motive, and it may be considered as governing him in each insurance. . . . The evidence offered that Hunter obtained the insurance in other companies on the life of Armstrong at or near the same time was, under these authorities, clearly admissible. It tended to establish the theory of the defendant that the insurance obtained in this case was obtained by Hunter upon the premeditate purpose to cheat and defraud the company. Especially would it have had that effect if followed by proof of the manner of the death of Armstrong.

"But independently of any proof of the motives of Hunter in obtaining the policy, and even assuming that they were just and proper, he forfeited all rights under it when, to secure its immediate payment, he murdered the assured. It would be a reproach to the jurisprudence of this country if one could recover insurance money payable on the death of a party whose life he had feloniously taken. As well might he recover insurance money upon a building that he had willfully fired."

MEDICO-LEGAL.

As a preliminary to the discussion of the relations of legal medicine to life insurance, it seems advisable to tell in a few words the plan which has been adopted in the subsequent pages. In this way the relations of the individual parts to the whole subject, and also their comparative importance, can be shown. And a certain coherency between the different topics will be established.

The opening section is devoted to a very brief review of the duties of the medical examiner, and a short statement of the value of medical selection. In the section following this are discussed the questions as to what constitutes medical attendance and medical attendant. Next is taken up the definition of "sound health." And immediately after this comes the correlated idea as to what constitutes "freedom from disease." This topic is first discussed in its general aspects, and then following this discussion are a number of diseases, each of which has been the subject of judicial comment. These are treated individually. Next is taken up a very important subject, namely, the habits of the insured in regard to alcohol, opium, and other narcotics. This is treated at considerable length, both on the legal and the medical sides. It has seemed advisable to insert it here, immediately after the discussion of health and disease, on account of its marked influence on both these conditions. The next topic taken up is that of the family record and its manifestations of heredity.

The remaining topics have less cognate relation to the main subject. But medical questions enter more or less into their discussion, and medical selection is somewhat affected by the statements in the applications regarding them. So they do not come amiss in this relation. The first of these topics has reference to the occupation, and then comes the subject of the residence, and that of the age immediately follows. The amount of other insurance that an applicant has frequently affects the acceptance of the risk, and of still more importance is the question referring to pre-

vious rejections. These are both discussed shortly. Last, but by no means least, is the very important topic of suicide in its relations to life insurance. This is discussed fully and at length. These have seemed to be the only subjects which can be properly included under the title we have chosen.

The Examiner.—Since we hope that many medical examiners for life insurance companies will honor this article by reading it, it has seemed right to us to preface it by a few words concerning their duties and the value of medical selection in eliminating unfit risks. "It is a truism to remark that the whole fabric of life insurance depends upon the fidelity, the learning, and the skill of medical men. When a company is formed, a lawyer may carefully draw its charter and its by-laws, and formulate the contracts upon which it is willing to enter; the actuary may accurately estimate the risks to be encountered, the rate of interest to be expected, and the loading necessary to cover expenses; the executive may organize with skill and economy the working force and the agents in the field; but unless the medical examiner does his duty in barring out undesirable risks and accepting only those who may reasonably be expected to live out the theoretical expectation of life, the company is predestined to loss and ruin. He stands as a sentinel at the gate to prevent the ingress of those who would only destroy the structure, and upon his vigilance and care depend its continued existence. Any lapse from the strict performance of duty, any concealment of facts which the company should know in order to estimate properly the risk to be assumed, and any approval of doubtful lives from motives of personal friendship or unwillingness to incur local enmities, is to admit a traitor to make a breach in the growing edifice which may easily result in its total downfall." (*The Chronicle*, 1893, p. 326.) And it can be said that the medical examiner seldom fails in the high trust reposed in his integrity and fidelity. He becomes the confidential adviser of the company, and shows toward it the utmost good faith in nearly all cases.

Oftentimes he sacrifices lifelong friendships to do the almost thankless task of rejecting an unsuitable applicant. It is seldom an applicant is so unsound as to die within a short time after rejection, for in that case he is usually so palpably sick that he does not dare to apply for insurance. Hence the examiner gets the approval of no one for rejecting the case, for it is buried at the home office along with thousands of others, and the applicant and agent usually have opportunity, for a year or two, to revile and upbraid the examiner. And when the rejected candidate finally dies within a time far short of his expectation, the medical examiner rarely gets his credit for it from the officers of the company, for they seldom hear of it. This is his own fault, and he should endeavor to correct it. For the sake of his own reputation he should report the deaths of all his rejected cases to the home office. Furthermore, it would prove of great scientific value to the company. But the examiner probably thinks that the damage already done in his immediate circle cannot be rectified, and he does not care to take the extra trouble to notify the company.

It is said, sometimes in jest but occasionally in earnest, that a life insurance company would be better off if the medical examination were abolished and applicants taken without examination; that the reduction in expense would more than counterbalance the increased loss from the

higher mortality. Those who advance this view seem to do so on the supposition that the effect of abolishing medical selection would be to bring the death-rate up to the average at large of the population, and they seem to think that it could go no higher; but there is every reason to believe that it would. Would not "the halt, the maimed, and the blind" come swarming to the doors of any insurance company which did away with medical examinations? Would not those over whom the family physician had shaken his head come rushing up to join the throng before it was too late? And equally would not those who knew they were in good health keep away from such an institution, as one avoids a pest-house? The net result of two such forces would be that in a short time the company would be composed, not of average risks, but of invalids, of those who had been rejected by other companies, of those only who knew they were unsound. How long could any company stand such a strain?

The great value of medical selection is well shown in the following tables. (*Assurance Magazine*, vol. xxiii., page 285.) The actual rates of mortality in them were taken from the experience of ten assurance companies in Scotland. The computed rates of mortality were based upon the deaths registered in Scotland during the ten years, 1855–64. For the benefit of those to whom the actuarial science is a *terra incognita*, we will say that the cases are grouped according to the number of years they have been insured, and not according to their age. The year 0 refers to the first six months of insurance.

The importance of selection for the first two or three years is well shown in the following table of deaths from all causes:

Years of Assurance.	*Actual Rates of Mortality.*	*Computed Rates of Mortality.*	*Actual Deaths to 100 Computed.*
0	.004592	.012809	35.85
1	.007622	.013166	57.90
2	.009894	.013705	72.19
3	.011498	.014206	80.94
4	.013161	.014759	89.17
5	.013079	.015290	85.54
6	.014254	.015929	89.49
7	.014893	.016613	89.65
8	.015342	.017301	88.68
9	.016296	.018010	90.49

It has also been said that those who can afford to pay for insurance are naturally a better class of risks than the average population, and hence the diminished mortality, after two or three years of insurance, is due to natural, and not medical, selection. Fortunately, Dovey has prepared other tables which enable us to refute this. Some diseases will show very slightly the effects of selection, while there are others in which its theoretical value cannot be questioned. In the first group naturally belong the zymotic diseases. There is nothing in a medical examination which would show any capacity for restraining the development of such diseases and preventing a fatal termination. We are not, therefore, surprised to find in the table devoted to this class that the actual mortality surpasses the computed mortality in the first year, and remains ahead of it for the remaining eight years. Dovey makes the suggestion that this is probably due to the fact that a larger proportion of the in-

sured come from towns than from the country, and cities are well known to be more troubled with this class of diseases. A similar result is to be noticed in the table devoted to the diseases of the digestive organs. If applicants wish to minimize their symptoms, an examiner will naturally reject only those cases in which a disease of this class is so far advanced that it affects the applicant's general health and gives rise to objective manifestations. For this reason we find that the actual mortality in cases dying of some disease of the stomach is below the computed for one and a half years only; and after that it practically equals or surpasses it.

Let us turn now to the other group of diseases, in which we would naturally expect to find much value from the medical selection. Among these diseases the most marked results would be seen in cardiac and tuberculous lesions. In both the examination is usually thorough, heredity plays an important part which is given due weight, and the previous history of rheumatism, hemoptysis, etc., helps materially in excluding undesirable risks. In other words, we would reasonably expect to find the full value of medical selection manifested, and we are not disappointed. The accompanying tables speak so well for themselves that further comment on them is unnecessary:

TUBERCULAR DISEASES.

Years of Assurance.	*Actual Rates of Mortality.*	*Computed Rates of Mortality.*	*Actual Deaths to 100 Computed.*
0	.000374	.003750	9.97
1	.000981	.003672	26.72
2	.001915	.003668	52.21
3	.002109	.003619	58.27
4	.002031	.003569	56.91
5	.001968	.003518	55.94
6	.002351	.003460	67.79
7	.002154	.003408	63.20
8	.001956	.003356	58.28
9	.002010	.003306	60.93

HEART DISEASE.

Years of Assurance.	*Actual Rates of Mortality.*	*Computed Rates of Mortality.*	*Actual Deaths to 100 Computed.*
0	.000198	.000917	21.59
1	.000436	.000980	44.49
2	.000657	.001049	62.63
3	.000764	.001121	68.16
4	.000990	.001197	82.72
5	.000738	.001272	58.02
6	.001228	.001358	89.83
7	.001100	.001440	76.38
8	.001422	.001525	93.24
9	.001274	.001612	79.03

These observations of Dovey are reinforced by the following extract from an essay, "On the Effects of Selection," by Mr. Emory McClintock: "Concerning medical selection in general, all known statistics go to show that it exerts a most important influence in favor of the office during the first years of insurance. That part of its influence which is conspicuous in varying the earlier percentages is due to the rejection of diseased

lives. It must not be forgotten that another, and perhaps equally important, function of medical selection is to repel members of short-lived families, who are themselves in fair health. The beneficial effect of such action continues for many years. Those who say hastily that medical selection does no good after five years of insurance, and that therefore any one may be taken without examination, provided the office assumes no risk until after five years have expired, take upon themselves a most serious responsibility."

The duties of a medical examiner are to a considerable extent clerical. He must record the answers of the applicant with care and fidelity. The omission to answer any question always costs much time and trouble. No matter how unimportant he thinks any question is, he must see that its answer is put down. If the applicant gives the history of any disease or injury, all the essentials must be carefully inquired into and recorded. If an applicant makes any statements to the medical examiner and he advises and directs the applicant to modify them, in so advising he may act as the agent of the company, and the latter is then estopped from subsequently setting up the falsity of the statements, thus modified, as a breach of warranty. (*Flynn* vs. *Life Assurance Soc.*, 78 N.Y. 568.) This, of course, supposes that there is no collusion between the applicant and the examiner.

The examiner should allow himself but little latitude in judging what is important or unimportant. This particular case may be the subject of a future trial, and every detail then necessary. The applicant may have made statements to other companies which conflict with what he is now telling. He may say now that his rheumatism was muscular, while before he said it was articular. But his cross-examination must be conducted with tact and adroitness, so carefully and quietly that it is regarded by the applicant as a conversation only. For he is now on a totally different footing from that on which he is when he seeks the physician's professional aid. Now he will mitigate any sickness and speak of its consequences lightly. An attack of *petit mal* will become a little vertigo; he forgets that he has to get up two or three times to pass his water. It is the examiner's business to get the true facts. In order to do this it is of great importance to insist upon the rule that no third person be present at the interview. People will often make confession of some detrimental circumstance to the doctor alone, when nothing would induce them to utter a word on the subject to any one else.

A few words must be said about proofs of loss and certificates of death. It would seem reasonable to assume that the plaintiff in a suit upon a policy to recover from the company would be bound to some extent by the statements made in the proofs of death. Such was the view taken in the case of *Life Insurance Co.* vs. *Newton*, 22 Wall. 32. "They were intended for the action of the company, and upon their truth the company had a right to rely. Unless corrected for mistake, the insured was bound by them. Good faith and fair dealing required that she should be held to representations deliberately made, until it was shown that they were made under a misapprehension of the facts, or in ignorance of material matters subsequently ascertained."

In the case of *Keels* vs. *Reserve Fund Association*, 29 Fed. Rep. 198, this misinformation was pleaded, and in consequence the beneficiary was allowed to prove that the death had occurred from accident, although the proofs of death made it to be the result of suicide.

In the case of *Goldschmidt et al.* vs. *Life Insurance Co.*, 102 N. Y. 486, to the proofs of death were added copies of the verdict of the coroner's jury and of the evidence presented to it, as was required by the company. The verdict of the coroner's jury was that the insured came to his death by suicide by means of potassium cyanide. The claimant, in the proof of death, said: "We do not admit that there was any such inquest, verdict, or evidence, and we deny that the purported finding of such alleged jury was true or well founded, and we deny the fact alleged to have been found by such jury, and we deny the truthfulness of the alleged evidence on which said verdict is said to be based." The court held that the verdict of the coroner's jury was of value in drawing attention to a possible mode of death, but that it was in no sense binding upon the plaintiff; in fact, it did not even throw the burden of proof upon them, but that it was necessary for the company to prove that the insured died by suicide.

Similarly the company is not bound by proofs of death which it receives, even though it does not question them at the time. Thus in the case of *Crotty* vs. *Life Insurance Co.*, 144 U. S. 621, it was said: "Nor is the fact that the proofs were received by the insurance company without question an admission on its part of the truth of all the matters stated therein. The purpose of proofs of death in life insurance and proofs of loss in fire insurance cases is to put the company in possession of the facts concerning the death or loss, as claimed by the beneficiary or insured, upon which it is to base its determination as to making or refusing payment; and when it receives such proof without question, it is an admission on its part that they are in form sufficient, but not that all the facts stated therein are true. The policy in this case called for proofs of death; and the company by its answer admitted that satisfactory proofs had been furnished. The fact that in the blank it had prepared and sent to be filled out it asked many questions which were answered by the claimant, and the proofs thus made were received without objection, did not prevent the company from challenging in court the truth of any fact stated therein, essential to the plaintiff's right of recovery, and did not amount to an admission on its part respecting such fact."

Medical Attendance.—There are two questions of considerable importance in life insurance, which must be treated together on account of their close relationship to each other. These are: What constitutes a family physician? and, What is included in the term medical attendance? The decisions have varied much, and frequently on small technical points, so that it will be necessary to study each case separately.

In the case of *Price* vs. *Life Insurance Co.*, 17 Minn. 473, the definition of family physician was discussed at length. The twenty-fifth question in the application was, "Name and residence of the family physician of the party, or of one whom the party has usually employed or consulted?" The answer was, "Have none." The majority of the court held as follows: "The phrase family physician is in common use, and has not, so far as we are aware, any technical signification. As used in this instance, and for the purpose of the testimony appearing in this case, the chief-justice and myself are of the opinion that it may be sufficiently defined as signifying the physician who usually attends and is consulted by the members of a family in the capacity of a physician. We employ the word 'usually,' both because we do not deem it necessary to constitute a person a family physician (as the phrase is used in this instance) that

he should invariably attend and be consulted by the members of a family in the capacity of a physician, and because we do not deem it necessary that he should attend and be consulted as such physician by each and all members of a family. For instance, the testimony in this case shows that at the time when the application for insurance was made the family of Richard Price consisted of himself, his wife, and three or four children. We think that a person who usually attended and was consulted by the wife and children of Richard Price as a physician would be the family physician of Richard Price in the meaning of the above, twenty-fifth interrogatory, although he did not usually attend on and was not usually consulted as a physician by Richard Price himself."

McMillen, J., did not agree with this part of the opinion, and said, with a great deal of propriety, that a man might have one physician for his family and another for himself; and that, according to the opinion above given, he would be obliged to withhold the name of his personal physician. This would certainly be contrary to the intent of the question. In concluding he says (p. 497): "I think the phrase, as used in this instance, means the physician who usually attends and is consulted by all or most of the members of the family of the person whose life is assured, and that the person thus assured, if he has medical attendance, must be one of the members attended by such physician." This definition seems a more reasonable one than that which prevailed.

In the case of *Cushman* vs. *Life Insurance Co.*, 70 N. Y. 72, the insured stated in his application that Dr. P. was his "usual medical attendant," but in the proofs of death Dr. O. stated that he had been "attendant physician" upon Cushman for the preceding five years, covering the period of the former declaration. It was held that this did not falsify the statement in the application, for "a party may have several 'attending physicians' and one 'usual medical attendant.'" Furthermore, Cushman was not responsible for the statements made by Dr. O.

If the company accepts any ambiguous or incomplete answer concerning medical attendance, and on the strength of it issues a policy, it must abide the consequences. It cannot then plead that this ambiguity or incompleteness estops the insured from recovering. Thus in the case of *Higgins* vs. *Life Insurance Co.*, 74 N. Y. 6, the question in the application was, "Name and residence of the family physician of the party, or of one whom the party has usually employed or consulted?" The answer was, "Refer to Dr. A. T. Mills, Corning, N. Y." It was proven that the insured had occasionally consulted another physician, but for no serious ailment, and to no greater extent than he had Dr. Mills. It was held that the answer above given did not affirm a fact, and so did not constitute a warranty. It was further held that the answer was indefinite and not responsive; that the company, having issued a policy on the strength of it, showed that they were satisfied with it. This is a fair view, and one that will commend itself to every lover of accuracy. The defense was a pure quibble, and had very properly no standing in court on this point.

As regards what is comprised under the term medical attendance, the decisions are varying and conflicting. It would seem as if the term ought to include all medical advice sought for by a person from a physician, whether that advice consisted in the administration or prescribing of medicines, the use of instruments or other applications, or simply the

regulation of the diet or other hygienic measures. Many a real disease is improved by the simple regulation of the diet without the use of a single drug. Notice how frequently sugar disappears from the urine after the elimination of starches and sugars from the dietary, and without other treatment. It is not at all uncommon, in some forms of Bright's disease, for albumen to disappear when the individual is put on a restricted diet, such as milk, with the addition of some simple mineral water which cannot be properly called a drug. On this point we are in accord with a number of decisions. In the case of *Cobb* vs. *Benefit Association*, 153 Mass. 176, the question in the application was, "Have you personally consulted a physician, been prescribed for, or professionally treated, within the past ten years?" The answer was, "No." The wording of the declaration and proposal was such that the court held that all the statements of the insured were representations, made material by express agreement that they were "full, complete, and accurate." This being decided, the court then held with reference to the question above stated as follows: "The plaintiff further contended that the question referred to in the application should be construed as referring to a specific disease, and that if the insured had consulted or been prescribed for by a physician for a pain that did not amount to a disease, his answer to this question would not prevent the plaintiff from recovering. The presiding judge declined to instruct the jury in accordance with this contention, and instructed them that if the insured, being as he supposed in need of a physician, went to one for the purpose of consulting him as to what was the matter with him, and had an interview, answering such inquiries as the physician deemed pertinent, receiving aid, advice, or assistance from him, that the insured consulted a physician within the meaning of the interrogatory; and further, that if they found that he went to a physician for the purpose of procuring aid and assistance from the physician as such, and the physician prescribed a remedy, or treated him professionally, either by giving him a prescription or by administering hypodermic injections of morphine (of which there was some evidence), then he was professionally treated within the meaning of the interrogatory, or professionally prescribed for. This ruling seems to us correct. . . . Even if the insured had only visited a physician from time to time for temporary disturbances proceeding from accidental causes, the defendant had a right to know this, in order that it might make such further investigation as it deemed necessary. By answering the question in the negative, the applicant induced the defendant to refrain from doing this."

A very similar conclusion was reached in the case of *Life Insurance Co.* vs. *McTague*, 49 N. J. L. 587. In an application for the restoration of a lapsed policy, the applicant averred that he had not "consulted or been prescribed for by a physician" since the policy was issued. It was held that these averments were warranties, and it was proven that he had consulted a physician, who had prescribed for a "cold." The Appellate Court in delivering its opinion (p. 592) says:

"The Common Pleas, in their opinion before us, declare that this fact did not show the representation to have been false, because it did not appear what sort of a prescription the doctor gave, whether one compounded by a druggist or made up of some common remedy. But it is obvious that this circumstance cannot be of the least importance in determining the truth or the falsity of the representation in question. That

representation did not aver a condition of health, or that it was requisite or proper to consult a physician. It averred that he had not consulted a physician or been prescribed for by a physician. The fact found contradicted this averment, whether the consultation and prescription related to a real disease or an apprehension of disease. Indeed, so material does such a representation seem to be to the contract proposed by the application, that, in my judgment, if made falsely and knowingly it would avoid the contract. But the materiality of the representation in this case is not in question, for, as we have seen, its truth is warranted. Its falsity appears from the fact found."

Another point seems correctly viewed in the case of *Cushman* vs. *Life Insurance Co.*, 70 N. Y. 72: "To constitute a medical attendance, it is not requisite that a physician should attend a patient at his home; an attendance at his own office is sufficient."

On the other hand, we have some decisions of an entirely different tenor, so liberal in their scope as to make one aghast at the elasticity of a language which will permit such strains. In the case of *Brown* vs. *Life Insurance Co.*, 65 Mich. 306, the policy was issued in 1883. In the application was the question, "Name of the physician who last attended life proposed, and when?" The answer was, "Dr. H., nine or ten years ago." At the trial Dr. G. testified that he had seen her professionally at her house five times in two months in 1880; Dr. S. had attended her professionally several times in one month in 1881; and Dr. V. N. had seen her fourteen times at his office in the time between October, 1882, and May, 1883. Against all this testimony the court held as follows: "As these questions and answers ought to be construed liberally in favor of the assured, I am of the opinion that the mere calling into a doctor's office for some medicine to relieve a temporary indisposition, not serious in its nature, could not be considered an attendance by a physician within the meaning of this question, nor would the calling at the home for the same purpose be so regarded. The jury should have been instructed that the attendance of the physician must have been an attendance upon the assured for some disease or ailment of importance, and not for an indisposition of a day or so, trivial in its nature, and such as all persons are liable to who are yet considered to be in sound health generally."

In the case of *Life Insurance Co.* vs. *Schultz*, 73 Ill. 586, the insured gave a negative answer to the question, "Has the party employed or consulted, individually, any physician? Please answer this yes or no. When yes, please give name or names and residence."

This would seem to be about as direct and unequivocal a question as could be put. It was entirely free from the uncertainty inhering in the terms family physician or usual medical attendant. It would seem to refer distinctly to the employment of any physician for any cause by the insured within a time limited only by his capacity for remembering. It was proven that the insured, about one year prior to his examination, had a large axillary abscess, which confined him to his bed for about a week, and that he was attended several times by a physician for this condition. Under these circumstances it would seem to any reasonable mind that the answer to the above question was a direct falsification. Of course the jury gave the usual verdict, and on appeal it was held: "By the particular form of the question, the mind is naturally directed to a time recent, and well might be to the subject-matter in connection

with which the question is asked, namely, the application for a life insurance, and fitness as a subject of insurance, and the question not unnaturally might be understood as an inquiry whether the party had employed or consulted a physician with reference to having his life insured. The auxiliary 'have,' as here used, serves to denote a tense, grammatically, which expresses an action past, and often that which is just past and completed. To allow the interrogatory, as put, to have reference to any accomplished event wholly disconnected with the application, and which may have taken place in any previous period of time then fully completed, would be to say that it covered the whole period of the applicant's life. To give any such effect to the interrogatory would be to make it extremely misleading to the applicant. We are of the opinion the question was not sufficiently definite and specific as regards time, to warrant the finding of a breach of warranty upon this point, from the fact of the insured having employed a physician six months or a year and a half before, in the way as testified." This case is particularly flagrant, as there was considerable medical testimony to show that the applicant died of pyæmia, which certainly might have had some connection with this abscess. This would seem to belong to that rare class of cases in which judicial liberty has become license.

In the case of *Dillebar* vs. *Life Insurance Co.*, 69 N. Y. 256, a ruling was made which was directly opposed to the doctrines we have stated in the section on partial and incomplete answers. In the application the following questions and answers are given:

"*Q.* Has the party had, during the past ten years, any sickness or disease? If so, state particulars, and the name of the physician or physicians who prescribed or who were consulted.

"*A.* Nine years ago had an attack of typhoid fever.

"*Q.* Have you employed or consulted any physician for yourself or your family? If so, give name or names and residence.

"*A.* Dr. Paine, Putnam, Conn., nine years ago; he is now dead."

It was proven that one year prior to examination the applicant had had an hemoptysis for which he was attended by a physician; and another physician testified that he treated insured and his wife only a few weeks before the application for insurance. In spite of this the Court of Appeals stated that: "It was not said that he had no other physician, and if a fuller and more precise answer was desired the defendant should have exacted it. It was full and complete so far as it went. If a question is not answered there is no warranty that there is nothing to answer. And so in the case of a partial answer, the warranty cannot be extended beyond the answer. Fraud may be predicated upon the suppression of truth, but breach of warranty must be based upon the affirmation of something not true. Here there was no warranty that the answer stated the names of all the physicians whom he had employed or consulted at any time. It is true that in the agreement annexed to the application it is said that the answers are warranted to be full. But what was intended by these words, and what had the assured a right to suppose was intended by them? Was it intended that the insured should lose the benefit of his policy, after parting with his money, if he omitted innocently or inadvertently to give the name of every physician who at any time had been employed for himself or for his family in any illness, however temporary or trifling? The circumstances under which the words were used forbid such

a construction. The assured had answered many questions calling for minute information on many subjects, and for the substantial truth of his answers he was responsible. The other thing to be provided against was the suppression of the truth, and hence in the agreement there is a warranty that the answers are full, and that no material circumstance has been 'concealed or withheld.' Taking all the language used, the meaning was that the answers were true, and that they were full, in the sense that the assured had not intentionally concealed or withheld any material fact or circumstance. The assured could not have understood from all the language used that if he answered honestly all the questions put to him, he was to lose the benefit of his policy in case he omitted some fact requisite to make any one of the numerous answers full, because his attention was not particularly called to it, or because it had escaped his attention or memory, or because he did not deem it material to a full answer. Warranties in policies of insurance are strictly construed. They will not be extended to include anything not necessarily implied in their terms."

This is not a ruling which will stand with time. Good faith on the part of the insured necessitated a more complete answer than was given. The facts concealed were material, and had they been disclosed, it is safe to assume that the company would never have taken the risk. Only by concealing these facts was the applicant enabled to obtain the insurance. The negligence which will omit to mention an hemoptysis occurring within a year is too culpable to be excused. The precedent here established is very bad, and at variance with other decisions on similar points.

Sound Health.—What constitutes sound or good health from a life insurance point of view? This phrase certainly does not mean absolute perfection of physical health, for on that construction hardly any one would be insurable. The actuarial calculations, on which are based the premiums of the company, are supposed to have for their foundation persons of average good health, but they do not require more than that. At the same time the boundary line between sound and unsound health is very ill-defined and unsubstantial, they merge into one another so insensibly.

Some of the old decisions on this point are more amusing than valuable now. Sir James Ross took out a policy of insurance for one year from October, 1759, and he then warranted that he was in good health. He died before the end of the year, and payment was resisted on the ground of a breach of this warranty. It was proven that he had received a wound in his loins, in the year 1747, which gave rise to incontinence of urine and fæces. It was shown that this had no connection with the disease of which he died. There was some medical testimony to the effect that the incontinence was not a disorder which tended to shorten life. Lord Mansfield said: "The question of fraud cannot exist in this case. When a man makes insurance upon a life generally, without any representation of the life insured, the insurer takes all the risk, unless there was some fraud in the person insuring, either by his suppressing some circumstance which he knew, or by alleging what was false. But if the person insuring knew no more than the insurer, the latter takes the risk. When an insurance is upon a representation, every material circumstance should be mentioned, such as age, way of life, etc. But where there is a warranty, then nothing need be told, but it must in general be proved,

if litigated, that the life was in fact a good one, and so it may be, though he have a particular infirmity. The only question is, whether he was in a reasonably good state of health, and such a life as ought to be insured on common terms." Needless to say, the jury promptly found for the plaintiff.

In another case, about the same time or a little later, the same judge remarked, in reference to a warranty of good health, that "such a warranty can never mean that a man has not the seeds of a disorder. We are all born with the seeds of mortality." To this there can certainly be no objection; but when the learned judge goes on to say that this warranty is not broken in the case of a man who was subject to the gout, one is startled. It is very likely, however, that his personal medical ignorance compared favorably with that of the times. Both of these cases would be thrown out of court at the present time.

After all, the question is, provided the man is not in absolutely perfect physical health, which condition from our own experience is the height of rarity, Is there a fair possibility that the ailment from which he is suffering will tend to shorten life in the degree in which he has it? This way of putting the question seems simple enough until it comes to a particular application. In the case of *Watson* vs. *Mainwaring*, 4 Taunton's Rep. 763, the term "good health" was construed very liberally. The insured concealed from the company the fact that he had had considerable dyspepsia. It was certified that this disease was the ultimate cause of death, although it was much disputed whether it was organic at the time of the application. The fact that he died from the dyspepsia would seem reasonably conclusive that it was organic. In spite of this it was held that "all disorders have more or less tendency to shorten life, even the most trifling; as, for instance, corns may end in a mortification; but that is not the meaning of the clause. If dyspepsia were a disorder that tended to shorten life, within this exception the lives of half the members of the profession of law would be uninsurable." By these generalities the judge completely ignored the fact that the insured had died from the same disease which he was proven to have had at the time he made application.

In more recent times the term has been construed very variably. On the one hand it has been held not to mean perfect physical health. Thus in the case of *Morrison* vs. *Life Insurance Co.*, 59 Wis. 162, it was said: "It would be most unreasonable to interpret the term 'in sound health,' as used in contracts for life insurance, to mean that the insured is absolutely free from all bodily infirmities or from all tendencies to disease. If that were its meaning, we apprehend that but few persons of middle age could truthfully say they were in sound health." Of very similar purport was the charge to the jury in the case of *Goucher* vs. *Life Insurance Assn.*, 20 Fed. Rep. 596: "The term 'good health,' as here used, does not import a perfect physical condition. It would not be reasonable to interpret it as meaning absolute exemption from all bodily infirmities, or from all tendencies to disease."

Some very good dicta are laid down in the case of *Peacock* vs. *Life Insurance Co.*, 20 N. Y. 293, 296. "The epithet 'good' is comparative. It does not require absolute perfection. When, therefore, one is described as being in good health, that does not necessarily nor ordinarily mean that he is absolutely free from all and every ill which 'flesh is heir to.'"

If the phrase should be so interpreted as to require entire exemption from physical ills, the number to whom it would be strictly applicable would be very inconsiderable. In applying terms somewhat indefinite, reference should be had to the business to which they relate. This rule is very necessary when construing a language which, like ours, is defective in precision. The most important question on applications for life in, surance is, whether the proponent is exempt from any dangerous disease-one which *frequently* terminates fatally. It is not usually deemed an objection that one has some slight physical disturbance, of which in all human probability he will soon be relieved, although it might possibly lead to a fatal disease. A slight difficulty, such as the sting of a bee, the puncture of a thorn, a boil, or a common cold, has sometimes induced complaints which have shortened human life; but this result is so infrequent and improbable that the mere possibility is disregarded in the business of life insurance." If any fault could be found with these excellent observations, it might be in the use of the word "frequently," which we have italicized. This objection, however, is practically obviated by the rest of the quotation.

An opinion which was more open to criticism was rendered in the case of *Brown* vs. *Life Insurance Co.*, 65 Mich. 306, 314. "The 'sound health' evidently meant in the application is a state of health free from any disease or ailment that affects the general soundness and healthfulness of the system seriously, not a mere temporary indisposition which does not tend to weaken or undermine the constitution of the assured. The instruction that the disease must be 'of serious nature' is objected to, and it may seem at first blush to be too strong a term to use; but it is difficult to see how a person can be in unsound health or unsound condition of body or mind without the disease that causes such condition is a serious one. If the affliction is of a permanent character, it must certainly be a serious one; and if it is merely temporary, and to pass away without serious results, it cannot well be said to render a person unsound in his general health. The word 'serious' is not generally used to signify a dangerous condition, but rather to define a grave, important, or weighty trouble." Against this we can say that there are numerous afflictions which are permanent but not serious, such as nasal catarrh, for example. Furthermore, lobar pneumonia is usually temporary, the mortality being only about fifteen percent., and recovery being generally complete. But no one would say that this was not a serious disease, or that, while it lasted, the individual was in sound health.

Now let us suppose that the insured, at the time of making application, had some disease of which he was entirely ignorant, and which was not inquired about in the application; and let us also suppose that he warranted that he was in good health. Such a case was presented in *Hutchison* vs. *Life Assurance Society*, 3 Bigelow's Life and Acc. Ins. Rep. 444. The case was submitted to the Court of Session in Scotland with a note from the lord ordinary, in which he said: "The defenders allege that there has been a breach of the warranty thus undertaken by the insured. And without going into the details, it will be found that their plea upon the warranty results in this: if it shall be proved that, at the date of opening the policy, Mrs. Armstrong was not healthy, or free from disease, but was affected by a particular disease (not being one of those particularly mentioned, and in regard to which a special query was put and

answer given), this amounts in law to a breach of warranty, although, to all appearance, and so far as her knowledge went, she was at the time in perfect and robust health, and had no disease whatever; and although there may have been no negligence or want of attention to render her actual ignorance inexcusable, the disease alleged to have existed never having exhibited itself, and being, while present in the frame, entirely undiscernible to all ordinary or even the most skillful observation. . . .

"Now, holding that in construing the warranty the intention of the parties must be found out by a reference to the subject-matter, it is difficult to see how the declaration of the party insured, that 'I am now' (that is, at the date of the policy) 'in good health and do ordinarily enjoy good health,' can be held to import a warranty or undertaking by the policy that he is free not only from any disease which has positively affected his health, but from any latent disease tending to shorten life, although it has never sensibly affected his health; and that the declaration must be true in the latter sense in order to support the policy. Such a declaration, it is thought, in its natural and obvious meaning, imports an answer to an inquiry capable of being answered by the party at whom it is made; and, therefore, has reference to the apparent and known condition, present or past, of the individual as respects his actual enjoyment of good or bad health, or to his positive experience in regard to health, and not to the possible existence of some disease, which, however injurious in its character, has had no perceptible influence upon the health, or no influence which can impeach the truth of the declaration —applying it to the feelings and experience of the party—that he is in good health and ordinarily enjoys good health. To extend the warranty undertaken by such a declaration so as to make it embrace the latter case would be an excessive stretch of its meaning, if indeed it will, by any violence, admit of that meaning being put upon it."

Further on in the same case Lord Fullerton makes these excellent remarks: "If the term 'good health' means the perfect, conscious enjoyment of all one's faculties and functions, and the conscious freedom from any ailment affecting them, or any symptom of ailment, the question may be asked and answered; but if the term is construed as meaning an absolute freedom from all defect or derangement, imperceptible as well as perceptible, the declaration is one which cannot be made, and which it would, therefore, be absurd to ask. And when the defenders represent it as a warranty, nothing is gained in the inquiry, because the question occurs, 'What is it which was warranted? Good health;' and that just leads to the same inquiry, in what sense the term was employed; for, it will be observed, there is here no express warranty by which a party may, and often does, take the risk of events or circumstances on which he possesses no present information. Here the warranty is at best only implied from the term of a declaration, asked by one party and given by the other, and which is made part of the contract; and as the term is used in mere declaration, its sense must be determined by that which it evidently bears in the passage containing it. The provision, that the declaration shall form the basis of the contract, may be held to render the declaration equivalent to a warranty; but still the point, what is declared, and consequently, what is warranted, depends on the construction of the declaration, and in choosing between the two senses of the disputed term, according to one of which a party may declare, while, according

to the other, it would be absurd to ask and impossible to give a declaration, the former sense must, according to every rule of construction, be adopted." The court finally issued an interlocutor, in which they said that the declaration "I am now in good health, and do ordinarily enjoy good health" imports "a warranty only to the effect that the declarant was and had been, according to her own knowledge and reasonable belief, free from any disease or from any symptom of disease material to the risk, and that they do not import a warranty against any latent and imperceptible disease, that could only be discovered by post-mortem examination, or from symptoms disclosing themselves at an after period of time."

This decision was certainly very liberal to the insured, but it was completely transcended in the case of *Life Association* vs. *Foster*, 4 Bigelow's Life and Acc. Rep. 520, and the doctrine expressed above was carried to an unreasonable length. In this case it appears that the insured had at the time of making application, and for some months prior, a swelling in the groin, the existence of which she knew. This was a hernia, which became strangulated and caused death within six months of the time of taking out the policy. She was asked in the application if she had rupture, and gave a negative answer, as she did not know the nature of the swelling in the groin. The following declaration was also made by her: "I undertake that, in the event of my having rupture, either now or at any other future time, I will constantly wear a properly adjusted truss." She did not comply with this declaration for the same reason, that of ignorance. The court held that there was no negligence on the part of the insured in not having mentioned the existence of the swelling in the groin, since persons without medical knowledge could not be expected to know that it was material, and that, as the answers were not absolute warranties, the policy was not avoided. It seems to us that the doctrine of irresponsibility from ignorance was carried to an extreme in this case, as the question about hernia was specifically asked and attention was again drawn to the subject by the declaration.

The opinion given in these two Scotch decisions is radically different from the decisions rendered in English cases. Thus in the case of *Duckett* vs. *Williams*, 3 Bigelow's Life and Acc. Ins. Rep. 8, it was decided that absolute truth must prevail. "A statement is not the less untrue because the party making it is not apprised of its untruth." But it must be noted, however, that the declarations in this case were made by third parties, and not by the insured. It might well be held that in such a case, where one states as a matter of fact that which is not within his own knowledge, with a view to induce another to enter into a contract, he does so at his own peril. Otherwise he should qualify his statements as being to the best of his knowledge.

The possibility of evading the issue is well shown in the case of *Fowkes* vs. *Loan Assn.*, 3 Best and S. 917. Here the proposal and declaration contained the proviso that if "any fraudulent concealment or designedly untrue statement be contained therein," the policy should be null and void. Although the statements of the insured were warranted, it was held that an untrue statement about good health did not avoid the policy unless it was designedly untrue.

Freedom from Disease.—This is another phase of the question just discussed. The insured states that he is free from some disease, specif-

ically mentioned, or from any serious illness. Of course the question arises, What constitutes a serious illness? Very good limitations were given in the case of *Goucher* vs. *Life Insurance Assn.*, 20 Fed. Rep. 596, where it was said that "clearly the term 'severe' or 'serious' illness does not mean slight temporary physical disturbances or ailments, speedily and entirely recovered from, not materially interfering with the pursuit of one's avocation, producing no permanent effect on the constitution, and not rendering the insurance risk more than usually hazardous."

The cases under this head can be divided into three groups. In one the contract is construed liberally in favor of the insured, he being usually held more or less irresponsible on account of ignorance. In the second group the statements are held to be warranties and the contract is interpreted very rigidly. In a third set there is evidence that the insured knew of the existence of the defects or diseases, and, so knowing, misrepresented them. We will discuss each group separately.

1. One of the earliest cases decided in this group was that of *Life Insurance Co.* vs. *Francisco*, 17 Wall. 672, 680. "The principal defense set up at the trial was that in the application for insurance false answers had been given to the questions propounded by the defendants. These questions were, in substance, whether the person whose life was proposed for insurance had had certain diseases, or, during the next preceding seven years, any disease, and the answers given were that he had not. It was in reference to this that the court instructed the jury that it was for them to determine from the evidence whether the person whose life was insured had had, during the time mentioned in the questions propounded on making the application, any affliction that could properly be called a sickness or disease, within the meaning of the term as used, and said: 'For example, a man might have a slight cold in the head, or a slight headache, that in no way seriously affected his health or interfered with his usual avocations, and might be forgotten in a week or month, which might be of so trifling a character as not to constitute a sickness or a disease within the meaning of the term as used, and which the party would not be required to mention in answering the questions. But again, he might have a cold or a headache of so serious a character as to be a sickness or disease within the meaning of those terms as used, which it would be his duty to mention, and a failure to mention which would make his answer false.'

"There is no just ground of complaint in this instruction, either considered abstractly or in its application to the evidence in the case. It was, in effect, saying that substantial truth in the answer was what was required."

The argument advanced in the preceding opinion has many points in its favor. But a little extension of the same idea borders on the unreasonable. The same court, in the later case of *Moulor* vs. *Life Insurance Co.*, 111 U. S. 335, 343, went to much greater length in this question. The declarations made by the insured were to the effect that statements "untrue in any respect" would avoid the policy. There was considerable proof that some of the diseases mentioned in the application had existed, although possibly unknown to the insured. By some adroit word-juggling the statements denying the existence of these diseases were converted into representations only, and it was then held as follows: "Looking into the application upon the faith of which the policy was issued and

accepted, we find much justifying the conclusion that the company did not require the insured to do more, when applying for insurance, than observe the utmost good faith, and deal fairly and honestly with it, in respect of all material facts about which inquiry is made, and as to which he has or should be presumed to have knowledge or information. The applicant was required to answer yes or no as to whether he had been afflicted with certain diseases. In respect of some of those diseases, particularly consumption and diseases of the lungs, heart, and other internal organs, common experience informs us that an individual may have them, in active form, without at the time being conscious of the fact, and beyond the power of any one, however learned or skillful, to discover. Did the company expect, when requiring categorical answers as to the existence of diseases of that character, the applicant should answer with absolute certainty about matters of which certainty could not possibly be predicated? Did it intend to put upon him the responsibility of knowing that which, perhaps, no one, however thoroughly trained in the study of human diseases, could possibly ascertain? . . .

"The entire argument in behalf of the company proceeds upon a too literal interpretation of those clauses in the policy and application which declare the contract null and void if the answers of the insured to the questions propounded to him were, in any respect, untrue. What was meant by 'true' and 'untrue' answers? In one sense that only is true which is conformable to the actual state of things. In that sense, a statement is untrue which does not express things exactly as they are. But in another and a broader sense the word 'true' is often used as a synonym of honest, sincere, not fraudulent."

Hence it was held that all that was required of the applicant was the utmost good faith in answering the questions. This seems rather stretching the meaning of "true," especially in view of the declaration made by the insured that statements "untrue in any respect" should avoid the policy.

In the case of *Horn* vs. *Life Insurance Co.*, 64 Barb. 81, this now familiar doctrine of irresponsibility from ignorance was carried to a still further point. "The applicant may not know enough of the human system to be aware of the existence of some affection of a vital organ. The victim of Bright's disease, or of an affection of the heart, liver, or lungs, may be, and often is, in the enjoyment of such a condition of health and strength as to lead him to the belief that his vital organs are all sound. It would be monstrous to hold, in such a case, that the applicant warranted himself to be sound as to those organs by an answer to the effect that he was never sick, or had no disease of those organs. The company retains their own medical advisers for the purpose of making a careful and scientific examination of all applicants for life insurance; and they are far better able to detect incipient disease than the subject, in most cases. I think these statements are not understood or intended by the parties as warranties. I think the judge at the trial properly held that the inquiry was one of honest and fair dealing on the part of the applicant, and that the statements concerning the condition of his health were not warranties. . . .

"The assured must state all that he knows bearing upon the condition of his health; and any untrue statement or concealment in this respect ought, justly, to render the policy void. In all respects, where it

appears, or it can be proven, that the applicant had any knowledge of the facts called for by the interrogatories, it matters very little whether the answer be held a warranty or not, inasmuch as an untrue statement will be a misrepresentation or fraud which will equally render the policy void." This is not an inequitable doctrine if strictly applied. Under it the whole burden of proving a man sound would be thrown upon the medical examiner; but it is well known that in the early stages of the diseases mentioned above, especially consumption and Bright's disease, the diagnosis can hardly be made without material assistance from the patient by informing the physician of every little symptom that he has. It is absurd to expect that an applicant for insurance will render such aid. On the contrary, he undergoes a species of self-deception and glosses over all that he can, even though he knows that he is not as strong as he has been. He does not do this exactly willfully or consciously, but still he does it. The result is that, unless these principles are very strictly applied, the company has to bear all the burden of the concealment of his condition. This often does not seem fair, nor what is reasonably to be expected by the insurer. For if it can be proved by collateral evidence that the insured had a certain disease prior to the time of examination, it seems reasonable to assume that, if he had fully and accurately told the examiner all his symptoms, the examiner would have been able to make the correct diagnosis by means of them and the physical signs which his examination would elucidate.

We have seen in many of the preceding cases that a strong endeavor was made to take the declarations and statements of the applicant out of the category of warranties through some wording of the clauses of the contract. This is notably the case in some of the American decisions, and in the Scotch cases brutal force was exerted to make the statements representations. This principle was very properly applied, however, in the case of *Benevolent Society* vs. *Winthrop*, 85 Ill. 537. The declaration contained the words "no misrepresentation or suppression of known facts." The court held that the contract should be construed in just this manner, and that the concealment must be a willful one in order to avoid the policy.

Similarly in the case of *Clapp* vs. *Benefit Assn.*, 146 Mass. 519, the applicant certified his statements "to the best of my knowledge and belief." It was held that this element of the applicant's knowledge must be considered in all his answers.

2. In this set of cases the statements of the insured have been held to be absolute warranties. There are no mitigating expressions in the contract and no doctrine of irresponsible ignorance which would tend to excuse the misstatements of the insured. These decisions seem to bear hardly at times upon the insured, and the tendency of the courts at present is undoubtedly toward the other interpretation. One of the stiffest decisions in this set is that given in the case of *Powers et al.* vs. *Life Association*, 50 Vt. 630. It was proven that the applicant had had heart disease for seven years prior to the application for a policy, although he very possibly might not have known it. It was held that the answers were warranties, and hence that "the applicant assumed the whole risk of the consequences if his answers turned out untrue. The existence of disease in an applicant for life insurance is the presence of the very peril that the company insures against. It is like insuring a building already

on fire. The question as to the health of the applicant is a preliminary one, to ascertain if he is an insurable subject. The force of the stipulations and conditions above recited is, to create a contract obligation on the part of the applicant that he was free from heart disease. He agreed that such peril and risk would not be encountered by issuing the policy, and if such peril did exist the contract should not be operative. Proof of the existence of heart disease established a breach of the underlying contract upon which the policy rested.

"It is wholly immaterial whether the applicant knew of the existence of the disease, because he agreed absolutely that it did not exist. Nor is it any answer to say that the question is a scientific one, and a layman might easily be deceived into a false answer. Scientific or simple, the applicant took the risk of the answer. If he had answered that he had no knowledge that the disease existed, the finding of the jury might affect the result."

Of very similar import was the decision rendered in the case of *Day* vs. *Life Insurance Co.*, 4 Bigelow's Life and Acc. Rep. 15, 23. "We are of the opinion that if the statements made by Day in the application, being part of the contract to procure the policy, were untrue in point of fact, the contract became null and void. This results from the form of the contract. It was evidently the design to protect the company from the ignorance, as well as the willful misrepresentations, of those applying for insurance. If, for instance, Day did not know or suppose that he had consumption, although in point of fact that fatal disease had already seized upon his lungs, his statements would be contrary to fact in an important respect, for no company would insure a life subject to so much risk. It would be untrue as matter of fact, and therefore fatal to the contract."

In the case of *Price* vs. *Life Insurance Co.*, 17 Minn. 473, one of the important rulings given by the Appellate Court was as follows: "But if he had any affection amounting to a disease of the kind mentioned, his negative answer would be a material misrepresentation, no matter how 'trifling' the character of the affection, nor whether it was remembered at the time of the application, nor whether it would have any influence on the length of his life, nor whether it would be noticed by the medical examiner."

In the case of *Baker* vs. *Life Insurance Co.*, 64 N. Y. 648, the court affirmed the rule that the policy having been issued upon the condition that, if the statements should be found untrue, the policy should be void, the untruthfulness of such statements avoided the policy, and it was immaterial whether they were made in ignorance or fraudulently. The statements in the application were warranties, but there was some evidence that the applicant knowingly misrepresented the facts, or that the ignorance amounted to culpability. This circumstance possibly determined the severity of the opinion.

Similar considerations may have influenced the court in the case of *Miles et al.* vs. *Life Insurance Co.*, 3 Gray 580. Here it was provided that if the statements of the insured, "upon the faith of which this agreement is made, shall be found in any respect untrue, then and in such case the policy shall be null and void." Testimony was presented that the insured for some time before the application had been troubled with bronchitis and consumption; that his father had died of consumption, and his brother

had been afflicted with some pulmonary trouble. He had denied all of these facts when making application, although possibly he was not aware of their existence. The court held that "the statements and declarations contained in the application for insurance, and referred to in the policy, were warranties; and if any of them, whether material or immaterial to the risk, were untrue, either from design, mistake, or ignorance, the plaintiffs cannot recover."

A similar question was raised in the case of *Vose* vs. *Life Insurance Co.*, 6 Cush. 42. Here the applicant died of consumption soon after the policy was issued. It was proven that he had the disease prior to the date of examination, although it was possible that he did not know it. The case was carried to the Appellate Court, and it was there held that "it is immaterial that the deceased did not suppose himself in a consumption; the fact was so, and the statement was manifestly contrary to the fact, which was a most material and conclusive fact." In the application he stated that he had had some general debility lately, but the court ruled that "the fact of the general debility of the system, as stated by the insured, was not important in the manner in which it was stated; as it might arise from a variety of causes not materially affecting the risk, and would not, therefore, by any means, give the insurers the information wanted."

3. In the second set of cases it was noticed that the severity of some of the decisions was influenced by the suspicion that the insured knew something of his condition before he applied for insurance. The third set of cases comprise those in which there is good evidence that the misrepresentation or concealment concerning health or previous disease was of facts known to the applicant, or that should have been known to him in all reasonable probability. Under these circumstances the courts are usually very severe in their decisions, and hold the insured closely to the line of his contract. In many of them high-sounding principles are laid down which do not well agree with those offered in the cases where irresponsible ignorance is advanced as a palliative. Thus, compare the opinion given in *Moulor* vs. *Life Insurance Co.* (p. 524) with that given in the case of *Life Insurance Co.* vs. *France et al*, 91 U. S. 510. Here it was proved that the insured was ruptured in 1846, in 1854, and in 1870, although from 1855 until after the examination in 1865 he was comparatively, if not absolutely, free from rupture. He was asked directly if he had ever had rupture, and denied it. There was no dispute that the insured knew that he had had a rupture prior to the time of making the application. Consequently the misrepresentation was one of facts known to him, even if it happened by accident. The court reviewed the case of *Jeffries* vs. *Life Insurance Co.*, 22 Wall. 47, and said: "It is only necessary to reiterate that all the statements contained in the proposal must be true; that the materiality of such statements is removed from the consideration of the court or jury by the agreement of the parties that such statements are absolutely true, and that, if untrue in any respect, the policy shall be void."

Cancer.—By this term nowadays is meant the carcinomata, and on a strict construction we think it should be limited to that group of neoplasms. Thus Payne says (*General Pathology*, p. 239): "The term cancer, which was formerly used in a clinical or physiological sense to signify tumors having the properties called malignant, is now a structural or ana-

tomical term, meaning tumors arising from epithelial tissues, and composed of epithelial cells irregularly arranged." Greene (*Pathology and Morbid Anatomy*) and also Satterthwaite (*Reference Handbook of the Medical Sciences*, vol. i.) use the term in a similar way. Some other tumors are fully as malignant as the carcinomata.

Only one case could be found in which the question of cancer arose. That is the case of *Cheever* vs. *Life Insurance Co.*, 5 Bigelow's Life and Acc. Cases 458. In it only the clinical aspects of the malignancy of the cancer were considered, and its histology was entirely overlooked. One or two years prior to the date of policy the applicant had a malignant tumor or cancer on his neck, which was made the subject of a medical consultation, at which it was determined to perform an operation. He changed his mind, however, and went to a quack, who healed up the open sore. Three years after the policy was issued the cancer recurred at the original site, and was operated on, but the insured died. The jury gave the usual verdict. On appeal the court held that the statements were only material representations, but said: "The point for the determination of the jury really was whether or not the recurrence of the cancer or tumor was the reappearance of the old trouble, or whether it was a new and distinct ailment occurring after the insurance was effected. If the former, there should have been a verdict for the defendant; if the latter, for the plaintiff. The court instructed the jury in effect, that if the party had once supposed and been told that he had cancer, and in alarm had engaged physicians to treat it as such, and they did so, but that after it healed they advised him that it was not a cancer or a serious ailment, and he believed them, and in fact it was not what he and they once thought and feared, he was excused from stating the facts, the same as he would have been had he, from eating green fruit or vegetables during the prevalence of cholera, been attacked with acute cholera morbus, and, in his alarm, called in several physicians to treat him, and who at the time thought his disease was cholera, but that all afterward ascertained the trivial nature of the complaint. But we think that the evidence established clearly that the insured had been, prior to his application, afflicted with a malignant fibroid tumor or cancer; that treatment had simply arrested it for a time without removing it from his system; and that it reappeared and caused his death. If we are right, he misrepresented the fact, though, as we think, innocently, under the belief that his ailment had been trivial, producing more of fright than of danger. But the effect of a misrepresentation of a material and positive fact, upon which an insurer relies, does not depend upon the good faith or honest belief of the applicant making the representation. Such representations must be true; and if not so, substantially, the liability of the insurer will be avoided where the truth of such representation is made the basis of the contract of insurance."

Under the construction of this decision, any malignant tumor would be included under the term "cancer." While this is incorrect anatomically, it probably represents the idea of the framer of the application, it being rather an old one. Hence the decision, although it might be technically incorrect, is probably in consonance with the ideas prevalent at the time the contract was consummated.

Consumption.—This is a term which is supposed to refer to several varieties of tuberculosis, especially pulmonary, laryngeal, and intestinal. It does not seem proper to embrace the other varieties of tuberculosis

within this designation. There are, however, several synonyms used by the laity which it is necessary to mention. These are hemorrhage of the lungs, abscess of the lungs, disease of the lungs, and chronic pneumonia. These terms are largely used by them in stating the cause of death of other members of the family. From the experience of a life insurance office we can safely say that they practically always mean consumption.

Consumption is a more frequent cause of death than any other disease. About fifteen percent. of all deaths are to be traced to this. When adults only are considered, this proportion reaches nearly one third. It is so common and widespread that all insurance companies guard as carefully as they can against admitting cases of it. The effect of this selection is very marked and important, but not complete. The method of examination as usually practiced by life insurance examiners is not sufficiently thorough to eliminate entirely this risk. It is no easy matter to detect, at times, the signs of incipient phthisis even under the most favorable circumstances and when the attention is drawn to it by the history of the patient. How much more difficult is it when the patient denies or conceals all pulmonary symptoms? But this selection of risks has a decided influence on diminishing loss to the insurer from this disease, as can be seen by the following table (*Mortuary Statistics of the Mutual Life Insurance Company of New York*, part ii.):

SHOWING THE ANNUAL NUMBER OF DEATHS FROM CONSUMPTION IN NEW YORK CITY AND IN THE MUTUAL LIFE, CALCULATED FOR 10,000 LIVING AT EACH DECENNIAL PERIOD OF LIFE.

Age in Decennial Periods.	*New York City.*	*Mutual Life.*
20 to 29 years	70	24
30 to 39 years	71	20
40 to 49 years	66	17
50 to 59 years	84	14
60 to 69 years	110	18
70 and upward	150	30

This table shows also how mistaken is the common impression that consumption is more prevalent between the ages of fifteen and thirty. To quote further from this statistical report: "This prevailing but erroneous opinion has originated, as suggested by Dr. Walshe, from merely counting the number of cases occurring at each year, or period of life, without taking into consideration the number of individuals living at corresponding ages to furnish the observed number of cases. For instance, there are nearly three times as many persons living at the ages of twenty to thirty years as at fifty to sixty years, and consequently, three times as many cases of consumption at the earlier period as at the later would only indicate an equal prevalence of the disease at both periods."

Undoubtedly many applicants are insured while they are in the first stages of phthisis. They find out that they have some trouble which is steadily debilitating them, but to which they do not care to give a name. Their own doctor is ignorant or deceives them. But they know that they are not capable of doing as much work as formerly, and that their physical health is deteriorating. For this reason they seek to make sure of some future means of sustenance for their families, realizing, probably in a vague way, that they are no longer certain of an apparently indefinite term of life. In this mood they come to obtain insurance, if they

can. But like the man whose toothache fled when he reached a dentist's door, their ideas on the subject of ill health undergo a radical change when it comes to telling their symptoms to the medical examiner. As a rule they do not intend to deceive, but the little trifles, which make up the early history in many cases of consumption, do not seem to be of sufficient importance to tell the examiner. They have not been told that they have phthisis, and of course they do not know it themselves, so what is the use of bothering the examiner with these petty details about a little dry cough, some loss of weight, and an occasional pain in the chest? Besides that, he is going to examine their lungs, and it is his business to find out if there is anything wrong there. And the old story is repeated in about six months or a year. The proofs of his death are handed in, the company looks up the case, and unless they find evidence of gross fraud, the death-claim is paid without protest, for the futility of an appeal to the jury, in such cases, is too well known to the loss department.

In the case of *Vose* vs. *Insurance Co.*, 6 Cush. 42, quoted on p. 528, the evidence was fairly conclusive that the applicant knew that he was quite sick, even if he did not know that he had consumption, of which he died soon after the issuing of a policy. The jury gave the usual verdict for the plaintiff, but on appeal it was held as follows: "It is immaterial that the insured did not suppose himself in a consumption; the fact was so, and the statement was manifestly contrary to the fact, which was a most material and conclusive fact. The fact of the general debility of the system, stated by the insured, was not important in the manner in which it was stated, as it might arise from a variety of causes not materially affecting the risk, and would not, therefore, by any means give the insurers the information wanted. The insured was asked directly whether he was at the time affected with any disease or disorder, and what; to which he answered that he could not say he was afflicted with any disease or disorder; but he could have stated the symptoms of consumption, which he had, and which he knew he had, and which he had had for five months previous; and which were most certainly material and important to be known by the insurers. It is believed that omissions or concealments less important than this, and without any intentional fraud, have been held to avoid policies upon life."

It is doubtful, however, if this opinion would be held to apply unless the evidence was reasonably conclusive that the applicant knew he was suffering from some illness at the time of examination. Otherwise there would be a doubt as to the commencement of the illness.

In the case of *Glutting* vs. *Insurance Co.*, 50 N. J. L. 287, and also in *Life Insurance Co.* vs. *Dempsey*, 72 Md. 288, there was apparently concealment of the symptoms and existence of phthisis, and on appeal the verdict of the jury was reversed.

An interesting point was decided in the case of *Scoles* vs. *Life Insurance Co.*, 42 Cal. 523. The question in the application was: "Have you had any serious illness, local disease, or personal injury; and if so, of what nature, and how long since?" Answer, "Not any." It was proven that he had consumption, which was defined as tubercles on the lungs, and also tubercles on the brain. On appeal it was held that these would come clearly within the definition of "a local disease." To this there can be no exception, for, although general miliary tuberculosis would probably be considered a constitutional disease in the same sense that

typhoid fever is, this is quite rare, and certainly other manifestations of tuberculosis are local.

Hemoptysis.—This is so striking a symptom, that its preëxistence is almost always asked by the companies. Furthermore, it is one that can hardly be overlooked by the subject.

The question is variously worded, the more common ways being "spitting of blood," "raising of blood," "coughing of blood," for it is reasonable to suppose that but few of the laity would understand what hemoptysis meant. As the question is usually put, it covers all sources of the hemorrhage from the lips and nose down to the pulmonary alveoli and the stomach itself, except when the term "coughing" is used. This way of wording the question is very comprehensive, but is more satisfactory to the companies; for many patients, if there is no further trouble from the hemorrhage within a short time, are apt to persuade themselves that the origin of it was something trivial, such as a sore gum or an inflamed pharynx.

As a symptom, it indicates in the large majority of cases some tuberculous affection of the throat or lungs. It may be due to a variety of other causes, but they sink into insignificance as compared with this. The table (*Mortuary Statistics of the Mutual Life Insurance Company of New York*, part ii.) from which the following quotations are taken has considerable value in this connection, for it is founded upon the statements of the laity themselves and their beliefs. The records of the cases were then submitted to careful medical scrutiny. All the doubtful ones, especially those in which there was any family history of phthisis, were carefully eliminated. The conclusions herewith given are only based upon those subjects which, after all these precautions to exclude the possibility of future phthisis, were finally accepted. The conclusions were as follows:

"The general ratio of the consumption mortality was 19.74 percent., while in these cases it is 34.92 percent., or nearly double. . . . Of the total 63 cases of hemoptysis, the date of its occurrence is stated in 39; in 13 cases the date of the hemorrhage was within seven years, in 22 cases within ten years. Of those occurring within seven years, 9, or 69 percent., died of consumption; of those occurring within ten years, 13, or 58.18 percent.; while in those cases in which the date of the hemorrhage was more than ten years before insurance, only 18.75 percent. died of consumption. . . . In less than half the cases the supposed source or cause of the hemorrhage is given, and in the majority of these it was reported as slight, as coming from the throat and nose, or as the result of an injury or excessive exertion. These explanations are mostly given in the consumptive cases, and our experience shows that statements indicating the cause of the hemorrhage are usually untrustworthy, as the patient always, and the physician sometimes, are apt to delude themselves with the most hopeful views."

These statements show how important an influence hemoptysis exerts upon the risk even after seven years. Hence the knowledge of its existence is of prime importance to the correct estimation of the prospect for longevity. Therefore, no matter how insignificant it may have been, it should be carefully stated in all cases. This opinion has good legal authority, for in the case of *Life Insurance Co.* vs. *Miller*, 39 Ind. 475, it was held that: "Whether the hemorrhage proceeded from one cause or

another, it was material and necessary that the statement in answer to the question relating to it should have been true."

This was more elaborately considered in the case of *Geach* vs. *Ingalls*, 14 M. and W. 95, and the following extracts from the opinions of the three judges who sat on the case are given as showing slight variations.

Pollock, C. B.: "By the expression 'spitting of blood' is, no doubt, meant the disorder so called, whether proceeding from the lungs, the stomach, or any other part of the body; still, however, one single act of spitting of blood would be sufficient to put the insurers on inquiry as to the cause of it, and ought therefore to be stated."

Alderson, B.: "By spitting of blood must, no doubt, be understood a spitting of blood as a symptom of disease tending to shorten life; the mere fact is nothing: a man cannot have a tooth pulled out without spitting blood. But, on the other hand, if a person has an habitual spitting of blood, although he cannot fix the particular part of his frame from whence it proceeds, still, as this shows a weakness of some organ which contains blood, he ought to communicate the fact to the insurance company, for no one can doubt that it would most materially assist them in deciding whether they should execute the policy; and good faith ought to be kept with them. So, if he had had spitting of blood only once, but that once was the result of the disease called spitting of blood, he ought to state it, and his not doing so would probably avoid the policy."

Rolfe, B.: "I have no doubt that, if a man had spit blood from his lungs, no matter in how small a quantity, or even had spit blood from an ulcerated sore throat, he would be bound to state it. The fact should be made known to the office, in order that their medical adviser might make inquiry into its cause."

To one point in these opinions we must take exception. There is no such disease as "spitting of blood," unless by this is meant that the blood comes from a diseased organ. It should be distinctly understood that hemoptysis is in all cases only a symptom, whether of a wound or of a diseased viscus. There may even be hemoptysis without any wound or disease, such as that occurring in vicarious menstruation, but these latter cases are notoriously short-lived, and the hemoptyses certainly cannot be called a disease in these cases. In view of these facts the existence of a single hemoptysis should be carefully stated, although by a quibble the contrary was held in the case of *Dreier* vs. *Life Insurance Co.*, 24 Fed. Rep. 670. The question in the application was: "Has the party had any of the following complaints? . . . Spitting or raising of blood?" Answer, "No." It was held that: "There is no warranty in this case that the insured never had spitting or raising of blood, but only that he had not had the complaint of spitting or raising blood, equivalent to a warranty that he had not blood-spitting in such form as to be called a disease, disorder, or constitutional vice. . . . If the question had been put to the applicant for insurance whether or not he had had any spitting of blood, or had had any symptom of disease, such as spitting or raising of blood, it would doubtless have required the disclosure of a single instance of blood-spitting."

It cannot be too strongly insisted upon that one single hemoptysis constitutes evidence of disease; for, to repeat, it is only the symptom of a disease, unless it comes from a wound. The disease may be trifling or grave, but that is for the company to judge.

Even more liberal is the opinion given in the case of *Singleton* vs. *Life Insurance Co.*, 27 Am. Rep. 321, 326, as follows: "We think evidence properly admissible to show in what sense the term 'spitting of blood' was used in the application. Without any evidence of the meaning of that term, the court might properly have instructed the jury that spitting of blood in consequence of a drawn tooth, or a cut on the gums, was not meant by that term, and yet if Anderson had spit blood from such trivial causes, literally the answer to his question would have been false. . . . There is something ambiguous in the term 'spitting of blood.' Literally the meaning is spitting of blood, whether from the teeth, gums, or lungs, but it would be absurd to hold that sense in the application."

Against these we can set, in pleasing contrast, the decision in the recent case of *Bancroft* vs. *Benefit Association*, 12 N. Y. Supp. 718. Here it was proven that the insured, about one year before the issue of the policy, spat a little blood after a fencing-bout; and that this was afterward considered to be due to a slight injury to his larynx from the foil. He denied this fact of the hemoptysis in his application. His statements were held to be warranties; it was found that "the said Bancroft was afflicted with the complaint of spitting of blood." This was sustained on appeal to the General Term.

Fits.—This term unfortunately is one that is used in a good many of the older applications. It is so indefinite and vague that it has no standing medically. The present tendency is to construe it as referring to epileptic convulsions alone. Thus the definition in the Century Dictionary is: "An attack of convulsive disease; a muscular convulsion, often with loss of self-control and unconsciousness; spasm; specifically, an epileptic attack."

In the old applications some importance was attached to it. As the distinction between the different varieties of spasms was not then well understood, the term probably then included other convulsions than epileptic. The use of the word in former times is well shown in the case of *Chattock* vs. *Shawe et al.*, 3 Bigelow's Life and Acc. Ins. Rep. 10. One Griswold was insured in 1831 and then stated that he was "in a sound and perfect state of health, and has not been afflicted with, nor is subject to, gout, vertigo, fits, hemorrhage, dropsy, etc." It was proven that he had had two fits, of an epileptic character, in 1827, but testimony was offered to show that they were the result of an injury to the head. The judge, in his charge to the jury, said: "The interpretation I put on a clause of this kind is, not that the party never accidentally had a fit, but that he was not, at the time of the insurance being made, a person habitually or constitutionally afflicted with fits; or a person liable to fits from some peculiarity of temperament, either natural or contracted from some cause or other during life."

Dyspepsia.—From a medical point of view, dyspepsia, strictly speaking, is of little consequence unless severe. The ordinary form, which every one has after eating too much or too rich food, has but little effect upon the expectation of life. If it becomes a chronic condition, its influence is more marked, not necessarily serious, however. But in many of these cases the term "dyspepsia" is used to cover more decided organic changes, such as chronic gastritis or even gastric cancer. It is, therefore, of some little importance to describe this condition with care

and accuracy, for it, associated with other conditions, might be sufficient to cause rejection. Owing probably to the misuse of the terms, dyspeptics are less desirable risks, and do not as a class come up to their expectation. We think that the opinion expressed in the case of *Morrison* vs. *Insurance Co.*, 59 Wis. 162, is excellent: "A touch of dyspepsia coming on, which manifests itself only after long intervals, which yields readily to treatment, and which is not shown to have been organic and excessive, is not inconsistent with a representation that a person is in sound health, as that term is employed in contracts for life insurance!" If the statements were warranties, it might be held otherwise; but even in this case it would seem correct to make the exception. A man in this day and generation can hardly remember every little attack of indigestion or dyspepsia, or reasonably be supposed to. In this connection the terms "dyspepsia" and "indigestion" should be considered synonyms, for the distinctions and differences between them are practically nil. Thus Wilson Fox (*Reynold's System of Medicine*, vol. iii.) uses them interchangeably with perfect freedom. The examiner must bear in mind that they are, after all, nothing but symptoms, and must closely question the applicant to see if there is a possibility of any organic lesion being present.

Disease of Heart.—Under this head would be naturally included all the lesions of the coverings of the heart, inside and out, as well as of the muscle substance, and even the functional diseases of the heart would properly be grouped here. It is hardly necessary to state that the term heart-burn is a symptom of a gastric disorder exclusively, and has no relation to the heart except in the situation of the pain.

The possibility of well-marked heart disease being present without the knowledge of the individual is thoroughly established. This is, of course, even more true of the lesser grades of cardiac involvement. Our own experience is that many cases are not recognized by the individuals from any symptoms which the heart gives rise to. Valvular disease can generally be diagnosticated on careful physical examination, although occasionally the murmur may be slight or even absent for some time. Other forms of cardiac trouble, such as adherent pericardium, myocarditis, etc., hardly admit of diagnosis without careful elaboration of the symptoms beforehand. This is also true of many of the functional forms which appear only at intervals, such as palpitation, angina pectoris, and paroxysmal tachycardia. Unless the individual is seen in an attack of one of these his condition can only be discovered by careful study of the symptoms as related by himself.

If the individual knew that he had heart disease at the time of the examination and willfully concealed the fact, it would be fraudulent. If he felt distinct symptoms from it but did not know whence they originated, the suppression of these symptoms would probably be considered a material misrepresentation, conformably to the rule laid down in *Vose* vs. *Insurance Co.*, 6 Cush. 42. But suppose that it had given rise to no symptoms noticeable to the applicant, and he had not been informed of its existence. We could find but one case bearing directly on this point; that is the case of *Powers et al.* vs. *Life Insurance Association*, 50 Vt. 630. It appears in this case that the applicant had been examined several years before for a pension, and at that time the heart disease was discovered but not mentioned to him. The life insurance examiner confessedly made a hurried examination, and did not detect the lesion. The appli-

cant died soon after, and on the trial these facts were brought out. In the Appellate Court it was held to be "wholly immaterial whether the applicant knew of the existence of the disease, because he agreed absolutely that it did not exist. Nor is it any answer to say that the question is a scientific one, and a layman might be deceived into a false answer. Scientific or simple, the applicant took the risk of the answer." This was construed thus literally because the statements of the applicant were considered to be absolute warranties. In most cases of this kind the language of the contract would be scanned very closely to see if the warranties could not be converted into representations, or if there were not some modifying words to break the force of an absolute warranty, in accordance with the established legal custom.

Rheumatism.—This is a term in which are included a number of conditions. Medically, it is often used with an excess of freedom; and little aches and pains in joints and muscles are often spoken of as "rheumatic" when they hardly amount to any disease. Included under this designation "rheumatism" are the following diseases: acute articular rheumatism, subacute articular rheumatism, chronic articular rheumatism, gonorrhœal rheumatism, and probably the rheumatism associated with certain infectious diseases, such as scarlet fever and puerperal fever, even though these latter may be due to septic poisoning. It is very doubtful if the so-called muscular rheumatism should be grouped under this head. On this point authorities are much divided. Flint (*Practice of Medicine*) calls muscular rheumatism "myalgia," and groups it with diseases of the nerves. Further he says (p. 807): "The term rheumatism, as applied to these affections, is manifestly inappropriate, and it is desirable that the name in this application should become obsolete." On the other hand, Strumpell (*Textbook of Medicine*) speaks of it in connection with the other rheumatisms, but he says (p. 863): "The two diseases [acute articular rheumatism and muscular rheumatism], therefore, are alike only in certain symptoms and in the fact that they are often, though not always, ascribable to wet or cold and the like."

Part of the importance of rheumatism from a life insurance point of view consists in its tendency to recurrence and its liability to invade the heart. This latter is more especially applicable to the acute and subacute articular rheumatism. Concerning the influence of the subacute forms on the heart, most writers are agreed. Thus Garrod (*Reynold's System of Medicine*, vol. i.) says: "As far as my own experience goes, it amounts to this, namely, that although the severer forms of the articular disease are very apt to be complicated with cardiac inflammation, yet even in the very slight forms, measured by the febrile and joint symptoms, serious mischief may arise in the heart; and several such cases have come under my own observation."

These statements seem a necessary prelude to a discussion of the case of *Price* vs. *Life Insurance Co.*, 17 Minn. 489. When the case came up for review by the Supreme Court, Judge Berry spoke with reference to this point as follows: "The thirteenth question and answer in the application were, 'Has the party ever had any of the following diseases?' (Naming several, and among others rheumatism.) Answer, 'Never.' . . . There was evidence in this case tending to show that the life insured had had subacute rheumatism. There was also evidence in this case tending to show that subacute rheumatism is not the disease of rheumatism

in the ordinary understanding of the term. There was also evidence tending to show that, technically and in medical parlance, subacute rheumatism is the disease of rheumatism. The rheumatism referred to in the question is the disease of rheumatism. Any rheumatic affection not amounting to the disease of rheumatism is not comprehended in its terms, any more than the spitting of blood occasioned by a wound of the tongue, or the extracting of a tooth, is the disease of spitting of blood mentioned in the same question. The life insured had the right to answer the question upon the basis that its terms were used in their ordinary signification. If there was any ambiguity in the question, so that its language was capable of being construed in an ordinary as well as in a technical sense, the defendant can take no advantage from such ambiguity." The principles enunciated in the beginning of this section would involve the inclusion of all forms of articular rheumatism under the designation rheumatism, no matter how light the attacks were. But if the inflammation did not involve the joints, it might possibly be construed as not rheumatic. Even on this point it would be reasonable to speak of it as rheumatic, as it is certainly considered so by the laity. While these would seem to be the fundamental principles, the difficulty arises that many cases described as subacute rheumatism are nothing but neuralgias, or other painful affections not rheumatic. This question would be one of fact for a jury to determine on the proper presentation of testimony. But in the ordinary as well as the technical sense of the words, subacute rheumatism must be considered one of the forms of the disease rheumatism.

Bright's Disease.—The views held by physicians about the lesions which should be grouped under this term are so diverse that it seems a mistake to use it at all in life insurance. Any misrepresentation concerning it can be so well excused that its value as a warranty is but little. It cannot be regarded as synonymous with nephritis, nor is even the latter term free from objection; for the condition of the kidneys which Flint (*Practice of Medicine*) calls parenchymatous degeneration Delafield and Prudden (*Handbook of Pathological Anatomy and Histology*) call acute parenchymatous nephritis. It is now proven that albuminuria is present in many conditions which are not indicative of inflammation of the kidneys and not due to any exudation further down the urinary tract. This fact of functional albuminuria is well recognized at present in insurance work. In 1892 we traced the after-history of forty-four cases of albuminuria which had been observed in the years 1875–78. (*New York Medical Examiner*, August, 1892.) Of these forty-four cases thirty were alive and in apparent good health in 1892. The physician of one stated that at intervals he had slight albuminuria—which fact we also confirmed—without apparent detriment to his health. The existence of casts even has been held not to be incompatible with freedom from organic disease of the kidneys. Furthermore, it is true that it is not easy at times to differentiate them from the so-called mucous cylindroids, which, in many cases, are certainly not indicative of any nephritis, whatever their origin may be. On the other hand, some cases of inflammation of the kidneys give but few symptoms in their early stages. In some of these cases an examination of the urine may reveal no abnormal constituents, either chemically or microscopically. Such a case might readily be passed by an examiner and die in a few

months from an acute exacerbation of a chronic condition. In fact, this has happened more than once, to our certain knowledge, after careful chemical and microscopical examinations by skilled physicians. From all these considerations it would seem much better to drop the terms Bright's disease and nephritis, and use in their stead, disease of the kidneys. This, we hold, would cover also all forms of albuminuria except those due to the presence of pus or blood from some part of the urinary tract below the kidney. For whether the albuminuria is transient or permanent, it is due to some affection of the kidneys, either functional or organic, which could properly be called a disease. We hold that a man, knowing that he had albuminuria and denying that he had disease of the kidneys, would be misrepresenting, within the limitations stated above.

In the case of *Insurance Co.* vs. *Young*, 113 Ind. 159, the term Bright's disease was discussed. The conflict of medical opinions was so great, however, that the court very properly declined to give any ruling on its use or meaning.

Tonsilitis.—In the case of *McCollum* vs. *Life Insurance Co.*, 55 Hun 108, it was held as follows: "It is argued, however, by counsel for the appellant that tonsilitis is not a sickness within the meaning of McCollum's answer in the application for these policies. It is shown, however, by the testimony of Dr. Eddy, that tonsilitis is an inflammation of the tonsils, called by the common term quinsy, and commonly results from a cold, and that a person who has had it is much more liable to have his throat affected by colds than he would otherwise be; that it is liable to make a man quite ill, and is oftentimes an indication of a scrofulous tendency. No effort was made at the trial to prove that the deceased was not in fact as ill as serious tonsilitis might cause him to be. But the deceased himself, who was a medical man, seems to have had no idea that tonsilitis was not a disease, for in the question put to him in his application to the Buffalo Life and Reserve Association he was asked when he was last attended by a physician, not for any mere ailment, but for 'what disease?' His answer was, 'Eight years ago; tonsilitis.'"

Although the opinion was undoubtedly correct on the evidence offered, the medical testimony is open to considerable criticism on the following points:

1. There are several varieties of tonsilitis, among them simple, follicular, diphtheritic, and phlegmonous.

2. The term quinsy is applied only to the last, and in this the majority of abscesses are peritonsilar, according to Brannan. (*Medical Record*, 1893, vol. ii., p. 549.)

3. The other forms of tonsilitis are often very mild and harmless, and might frequently well be described as "a mere ailment."

Disease of the Liver.—Under this term are properly included a number of conditions so well known that it is unnecessary to mention them here. The liver, however, is unjustly accused of many crimes, and it becomes advisable to consider the limitations of the term. Jaundice should not be included, for it is properly only a symptom of some disease which may or may not be of the liver. It seems to us that the passage of a gall-stone should be regarded as a disease of the liver, although it arises outside of the liver, strictly speaking. We think that the term liver in this connection includes its appendages, the gall-bladder and the ducts.

"Biliousness" is applied by the laity to so many conditions, most of which have no connection with the liver, that its inclusion here does not seem warranted. In fact, it is doubtful where it would be placed, for it is never "a serious illness."

We heartily approve of the limitations of the term "disease of the liver," laid down in the case of *Cushman* vs. *Life Insurance Co.*, 70 N. Y. 76. "In construing contracts words must have the sense in which the parties used them; and to understand them as the parties understood them, the nature of the contract, the objects to be attained, and all the circumstances must be considered. By the questions inserted in the application, the defendant was seeking for information bearing upon the risk which it was to take, the probable duration of the life to be insured. It was not seeking information as to merely temporary disorders or functional disturbances having no bearing upon general health or continuance of life. Colds are generally accompanied with more or less congestion of the lungs, and yet in such a case there is no disease of the lungs which an applicant for insurance would be bound to state. So most, if not all, persons will have at times congestion of the liver, causing slight functional derangement and temporary illness; and yet in the contemplation of parties entering into contracts of life insurance, and having regard to general health and continuance of life, it may safely be said that in such cases there is no disease of the liver. In construing a policy of life insurance it must be generally true that, before any temporary ailment can be called a disease, it must be such as to indicate a vice in the constitution, or be so serious as to have some bearing upon general health and the continuance of life, or such as according to common understanding would be called a disease."

A similar ruling was given in the case of *Life Insurance Co.* vs. *Trust Co.*, 112 U. S. 250. It was held that: "Unless he had an affection of the liver that amounted to a disease—that is, of a character so well defined and marked as to materially derange for a time the functions of that organ—the answer that he had never had the disease called affection of the liver was a 'fair and true' one; for such an answer involved neither fraud, misrepresentation, evasion, nor concealment, and withheld no information as to his physical condition with which the company ought to have been made acquainted."

In the case of *McGrath* vs. *Life Insurance Co.*, 6 N. Y. State Rep. 376, it was held that jaundice and torpid liver were not organic ailments of the liver; that their existence was not fatal even in view of the warranty that the insured never had disease of the liver.

Diseases of the Eye.—Many of the more serious ocular disturbances, such as glaucoma, cataract, iritis, etc., would properly come under this designation. But it seems reasonable to consider that errors of refraction do not amount to a disease. This is the view taken in the case of *Cotton* vs. *Life Insurance Co.*, 41 Fed. Rep. 506, where it was held that myopia was not included under the term bodily infirmity. This would probably not hold if the question referred to impairment of sight directly, but even in this case there would be some doubt, provided that the error was well corrected by glasses. The term impairment of sight might well be held to refer to some disease of the eye which prevented normal acuteness of vision. In examining applicants we have noticed that, as a rule, they say their sight is good even if they are wearing

glasses at the time. This is so regularly the case that we have concluded that laymen do not consider their vision impaired simply by some error of refraction which is corrected. In view of this fact, a judicial interpretation of the term impairment of vision might be held not to include errors of refraction, unless severe or uncontrollable. In *Fitch* vs. *Life Insurance Co.*, 2 N. Y. Sup. T. and C. 247, it was proven that the insured had had, six years before the issuing of the policy, conjunctivitis, due to some injury to the eye. This was considered to prove a breach of warranty, as he had a negative answer to the question, "Have you ever had any illness, local disease, or any injury in any organ?" But on appeal (59 N. Y. 557) it was decided that the statements were not warranties, and it was held: "We think that, according to the construction we have put upon the contract in question, the judge would not have been justified in holding that the omission to mention a temporary injury to the eye by sand being thrown into it, which had produced inflammation six years before the policy was applied for, and which was then cured, was conclusive evidence of fraud, or a breach of warranty sufficient to avoid the policy. If of any importance, it was at most evidence of fraud, to be submitted to the jury."

Headaches.—It is out of the question to enumerate the different causes of headaches. In themselves they are, of course, only a symptom, and may be due to either functional or organic disturbances. They are not a cause of death directly unless they lead to suicide. As a symptom they have a bearing upon the risk, and a question with reference to them is usually asked in the application. It is generally worded so as to cover only severe or frequent headaches, or the question is directly asked, "Are you subject to headaches?"

How these questions would be construed it is not possible to state, as we have not been able to find a decision bearing upon this point.

Even if they are severe and frequent, headaches are not necessarily indicative of any intracranial disease. In many of the worst cases, they are due to some general dycrasia, such as gout, or to some local disease of another organ, such as Bright's disease or some peripheral irritation, such as an uncorrected error of refraction. In view of these facts, we must indorse the decision rendered in the case of *Higbie* vs. *Life Insurance Co.*, 53 N. Y. 603. In the application in this case occurred the question, "Are the functions of the brain, the muscular and the nervous system, in a healthy state?" Answer, "Yes." It was proven that the applicant had been subject to severe headaches for several years. But the court very properly held that the question above stated "did not include a temporary or occasional physical disturbance the result of accidental causes; that there was no evidence that the recurrence of the periodical headaches had an origin or cause indicating any mental unsoundness or derangement of the head or brain or permanent disease, or that the fact of their existence was at all material to the risk."

Cold.—This is an utterly unscientific term, used to designate a number of affections supposed to be due to the action of cold. When used as the name of a disease, it would mean an acute catarrhal inflammation of the nose, larynx, trachea, or bronchi. It is rarely serious except at the extremes of life, and in the vast majority of cases is not worth mentioning.

This view of its importance is borne out in the opinion rendered in the case of *Life Insurance* vs. *McTague*, 49 N. J. L. 587, where it was held

that a cold, even if prescribed for by a physician, did not necessarily show that it had produced either disease or sickness; that it was not inconsistent with the statement that he had not been sick or afflicted with any disease. Presumably its existence at the time of an examination is incompatible with a warranty of sound health at that time, although in view of the principles laid down in the case of *Cushman* vs. *Life Insurance Co.*, 70 N. Y. 76 (see p. 539), this view might be questioned.

Habits.—For the purposes of life insurance, this term refers only to the various forms of drug-addiction. Getting up late, eating too much and too fast, wet feet, and such other bad habits, are not considered of importance to know about. Nor does the insurer regard it of any consequence to know the amount of tobacco, tea, and coffee consumed by an individual, since the capacity to assimilate these varies so greatly. If they are taken to an excessive degree, they promptly show harmful effects by causing functional disturbances of various kinds; and then the applicant would be rejected on account of these functional disturbances, and not on account of the abuse of tobacco, tea, or coffee. Consequently we mean the use of alcohol, opium, chloral, and other narcotics. Of these by far the most important is alcohol.

The question of the drinking habit can be divided into two phases, the first with reference to past and present custom, and the second with regard to the restriction of future excesses. In order to elicit information concerning the first, the application contains some questions about the habits, such as, "Do you now, or have you ever, used intoxicating liquors?" or, "Have you always been sober and temperate?" or, "Are the party's habits of life temperate or otherwise?"

The second is accomplished by inserting agreements and provisos which restrict future excesses, but with considerable variations in the details. Their general idea is that, if the insured die in consequence of the use of alcoholics, the policy shall be, wholly or in part, avoided. If an applicant proves that he has always been temperate, most companies assume that he will continue so, and therefore do not require any agreement with regard to future excesses.

It has uniformly been held that, if the question refer only to past and present habits, it will in no way be construed as referring to future excesses. Hence it might be possible to subdivide this subject into these two categories; but this is not practicable, and is of no consequence, since the gist of the whole matter lies in the definition of the words "temperate and sober." We will first consider what the legal decisions on this point have been, and then see how they comport with the medical ideas on the same subject.

1. If the questions or provisos are so worded as to indicate total abstinence without the possibility of any mistake, then they must be literally construed, and nothing but the total abstinence from all alcoholic liquors will suffice. Thus, in the case of *Hogin* vs. *Supreme Council*, 76 Cal. 109, the assured agreed to abstain wholly from alcoholic liquors, the association being composed only of prohibitionists. He broke his pledge, and by so doing avoided the policy, without reference to anything else. Of a somewhat similar purport is the decision in the case of *Shader* vs. *Life Assurance Co.*, 66 N. Y. 441, although here no question of total abstinence enters. In this case the proviso was that: "No claim shall be made under this policy where the death or injury may have happened

while the insured was, or in consequence of his having been, under the influence of intoxicating drink." It was held that proof was not required that the use of intoxicating drinks was the moving cause of death, but only that he was under the influence of stimulants at the time of death.

2. When the words used in the question are "temperate and sober," it has been held that this expression in no sense means total abstinence from all intoxicating liquors. Thus, in the case of *Brockway* vs. *Life Insurance Co.*, 9 Fed. Rep. 249, the questions were, "Is the party sober and temperate? Has he always been so?" The answer to each was, "Yes." In the charge it was laid down that "the words 'sober and temperate' are to be taken in their ordinary sense. The language does not imply abstinence from intoxicating liquors. The moderate, temperate use of intoxicating liquors is consistent with sobriety. But if a man uses liquors to such an extent as to produce frequent intoxication, he is not sober and temperate within the meaning of this contract of insurance." The latter part of this decision may be considered too liberal, as we shall see later, but it is to the first part that we now wish to draw attention. The same idea is well brought out in the case of *Meacham* vs. *Insurance Association*, 120 N. Y. 238. There the questions were, "Is the applicant temperate and correct in his habits? Does applicant agree to remain so?" The answer to each was, "Yes." The Court of Appeals held that: "The word 'temperate' suggests moderation, not abstinence, and the warranty is to the effect that his habit is to refrain from excessive indulgence in the use of intoxicants, and not that he abstains from all use."

3. We have seen in the preceding section that temperance does not necessarily mean total abstinence, but from the very necessities of the subject no hard-and-fast definition of temperance can be given. In the case of *Van Valkenbergh* vs. *Life Insurance Co.*, 70 N. Y. 605, it was held that the question, "use any intoxicating liquors or substances?" did not direct the mind to a single or incidental use, but to a customary or habitual use. This idea is also very well expressed in the case of *Holterhoff* vs. *Life Insurance Co.*, 4 Bigelow's Life and Acc. Rep. 395. Here the questions were, "Is the party sober and temperate? Has he always been so?" The answer to each was in the affirmative, and these answers were held to be material representations. Judge Tilden, in his charge to the jury, which was afterward approved by the higher court, said: "The statement itself amounts to an assertion that the insured at the time of the application was sober and temperate, and had always been so. As a matter of construction, it is manifest and clear to the court that these words, taken, as they are placed, together, refer to the character, habit, or state of the party, and that they are fairly convertible into the phrase or statement that the party was, and always had been, a sober and temperate person. The question of fact will then be, 'Was he such?' In considering this question you will inquire whether or not he continued the use of intoxicating liquors sufficiently long, or repeated libations sufficiently often, to amount to a habit; and if he did, then whether such habit, considered in reference to its extent or degree of indulgence, was such that he was not temperate and sober."

In the case of *Life Insurance Co.* vs. *Davey*, 123 U. S. 739, it is worth while to note the distinction drawn between intemperate and habitually intemperate. Here it was provided that if the insured should become

"so far intemperate as to impair his health or induce delirium tremens, or if his death shall result from injuries received while under the influence of alcoholic liquors," the policy might be avoided. On appeal it was held that: "If the substantial cause of the death of the insured was an excessive use of alcoholic stimulants, not taken in good faith for medical purposes or under medical advice, his health was impaired by intemperance, within the meaning of the words 'so far intemperate as to impair his health,' although he may not have had delirium tremens, and although previously to his last illness he had not indulged in strong drink for such a long period or so frequently as to become habitually intemperate."

In England, in the case of *Southcombe* vs. *Merriman*, 1 C. and Marsh 286, the assured stated that he was of temperate, sober habits. It was held sufficient to avoid liability under the policy to prove that he was intemperate, but not necessarily to such a degree as to impair his health.

Unfortunately, this opinion has not always been adopted in America. Thus, in the case of *McGinley* vs. *Life Insurance Co.*, 8 Daly 390, the question was, "Are the party's habits of life temperate or otherwise?" To which the answer was, "Temperate." It was held that this "rather depended upon the individual, for what would be temperate in the use of alcoholic drinks in one man would be intemperate in another; that the taking of a moderate amount of liquor in a weak man might be an intemperate act, when it would not be by a man of vigor and strength; that it is not in the use of alcoholic drinks that intemperance exists, but in taking them to such an extent as to impair the constitution and general health." This does not take into account the very unfavorable effect which alcoholics have on the prognosis of all acute diseases or their influence in producing accidents. These are factors of great importance, as we shall see later, but they seem to be entirely ignored in this as in many of the other decisions.

The great value of an Appellate Court is shown in the case of *Miller* vs. *Life Insurance Co.*, 34 Iowa 222, and also to what extremes a jury will go in cases of this kind. It was provided that the policy should be forfeited if the insured should die "by reason of intemperance from the use of intoxicating liquors." It was proven that he was a confirmed drunkard. At last, after a spree of several days, he developed delirium tremens. While in this condition he escaped from his keepers and ran about the city in his night-clothes. It was proven that the congestion of the lungs and brain, of which he died, were due to exposure and that to intemperance, and hence the policy should be avoided. These facts were hardly questioned, but yet the jury promptly returned a verdict for the plaintiff. The case was carried to the Appellate Court, the judgment was there reversed, and the case was sent back for another trial. It was a second time taken to the highest court, whose opinion (39 Iowa 304) was as follows: "How, in view of the evidence and the law given by the court, an impartial and unprejudiced jury, indifferent as between the parties, and anxious to ascertain the truth and effectuate the right, could return a general verdict for the plaintiff, and find specially that the congestion of the lungs and brain which caused Miller's death was not caused by the intemperate use of intoxicating liquors, passes our comprehension. . . . We interfere with the verdict of a jury always reluctantly, and never unless it is clearly unsupported by the evidence, or has been otherwise improperly reached.

"We deprecate the necessity which impels us a second time to set aside a verdict upon substantially the same testimony. But it were much more to be deprecated if the pertinacity of a jury could override law and right and give triumph to injustice and wrong."

An interesting and, so far as we know, unique question is presented in the case of *Jarvis* vs. *Life Insurance Co.*, 5 Ins. L. J. 507: Does intemperance, leading to insanity, and that to suicide, avoid the policy if there are provisos against both insanity and intemperance as causes of death? In this case there were provisos against suicide and also against intemperance. The jury were charged as follows: "If you should find that his intemperance produced the mental condition relied upon to avoid the effect of the self-destruction clause in the policy, then the plaintiff cannot recover. If the insanity was produced by habits prohibited by the policy, then it cannot be set up in avoidance of a breach of another condition. Intemperance avoids the policy, and if intemperance produced the insanity, this insanity cannot be set up as an excuse for the violation of the proviso against self-destruction." Unfortunately, the jury disagreed, so the case has not yet been carried to one of the higher courts.

4. We have grouped in this section some opinions against which we can only offer our most earnest protest. They abuse language, medicine, and sense so grossly that it seems impossible for them to prevail ultimately. We do not doubt that they will be recanted, but their influence is very bad while it lasts.

The first degree of liberality is probably represented in the charge of the judge in the case of *Fox* vs. *Life Insurance Co.*, 4 Bigelow's Life and Acc. Rep. 458: "Now, what is the meaning of these words in the fifth question, 'Have you always been sober and temperate?' It does not mean total abstinence. We are to give these words the common, ordinary interpretation. It does not mean total abstinence from drink, and there is no man who takes a glass or two when he feels like it who would not describe himself, in answer to that question, a sober and temperate man. As to the question of what constitutes sobriety, or to mean a temperate man, I suppose there are classes of people in the community who hold different opinions. . . . On the other hand, there are a class of people who would drink a great many times a day and become very much under the influence of liquor, who, perhaps, because they never become what is termed 'dead drunk,' would say, if they were asked this question, 'I take an occasional glass,' or, 'Yes, I occasionally take too much.' Well, I need not say to you that an occasional debauch even would not make a man of intemperate habits. I take it that this question means habitual intemperance. Especially it means so when you consider the word 'always.' If the question to be put to a man obtaining a life insurance policy is, 'Have you always been sober and temperate?' and if that means, 'ever drunk in your life,' I am afraid there would be a great many people who would never get their lives insured. There are very few who have not some time or other, young or old, been drunk literally and fully, and are conscious of it, so that they could not give an affirmative answer if such were the meaning of it; but it means habitual drunkenness. . . . The risk may be increased by habitual drinking every day of an amount of liquor that perhaps would not at all affect his head or his legs." There was the usual verdict for the plaintiff, but it was set aside and a new trial ordered, the outcome of which was not reported. To this charge we

must take great exception, not only medically but logically. Let us strip his propositions of verbiage, and then arrange them in orderly sequence.

1. "I have always been sober and temperate."
2. This statement does not imply total abstinence.
3. An occasional debauch does not make a man intemperate.
4. This statement therefore disaffirms only habitual drunkenness.

If we look back now from proposition 4 to proposition 1, we can readily see how untenable his argument is.

A very similar ruling, but by a higher court, was given in the case of *Life Insurance Co.* vs. *Reif*, 36 Ohio St. 596: "An occasional excess in the use of intoxicating liquors does not, it is true, constitute a habit, or make a man intemperate within the meaning of this policy; but if the habit has been formed and is indulged in of drinking to excess and becoming intoxicated, whether daily and continuously, or periodically with sober intervals of greater or less length, the person addicted to such a habit cannot be said to be of temperate habits within the meaning of this policy. . . . Where the general habits of a man are either abstemious or temperate, an occasional indulgence to excess does not make him a man of intemperate habits. But if the habit is formed of drinking to excess, and the appetite for liquor is indulged to intoxication, either constantly or periodically, no one will claim that his habits are temperate, though he may be duly sober for longer or shorter periods in the intervals between the times of his debauches."

It has even been held that an attack of delirium tremens is compatible with temperate habits. This opinion is so novel and the authority is so high that we think it worth while to give the case (105 U. S. 350) in some detail. One Badenhop was insured by his creditor, Foley, in January, 1872. In January, 1875, Badenhop died. His statements were made warranties by express stipulation. To the questions, "Is the party of temperate habits? Has he always been so?" he answered, "Yes." At the trial his family physician testified that in 1871 and 1872 Badenhop was drinking hard; that during that year he had attended him for delirium tremens, and once or twice for indisposition, produced, as he thought, from the excessive use of intoxicating drinks. The Circuit Court charged that if the jury found his habits in the usual, ordinary, and every-day routine of his life were temperate, then such representations were not untrue within the meaning of the policy, although they might find that he had an attack of delirium tremens, resulting from an exceptional over-indulgence in drink prior to the issue of the policy. On appeal to the United States Supreme Court, Justice Field stated the opinion as follows: "The charge given by the court, as stated above, correctly presented the law of the case. The question was as to the habits of the insured. His occasional use of intoxicating liquors did not render him a man of intemperate habits, nor would an exceptional case of excess justify the application of this character to him. An attack of delirium tremens may sometimes follow a single excessive indulgence. Ray, in his treatise on medical jurisprudence, says that, though it most commonly occurs in habitual drinkers after a few days of total abstinence from spirituous liquors, it may be the immediate effect of an excess or a series of excesses in those who are not habitually intemperate as well as in those who are. In the American Encyclopædia, under the head of 'Delirium Tremens,' it is stated that it sometimes makes its appearance

in consequence of a single debauch; though commonly it is the result of protracted or long-continued intemperance. . . . The court, therefore, did not err in instructing the jury that if the habits of the insured in the usual, ordinary, every-day routine of his life were temperate the representations made are not untrue within the meaning of the policy, although he may have had an attack of delirium tremens from an exceptional over-indulgence."

In this case the question was, "Has the party always been of temperate habits?" and it was held that the continuance of these temperate habits was not broken by an attack of delirium tremens. We do not claim that an occasional spree of a night is incompatible with temperate habits as they are commonly regarded nowadays; but an attack of delirium tremens is not due to a drunk of one night, but in the shortest case it takes many nights and days to bring on an attack. We have looked up the etiology in a number of treatises, and append herewith the results:

"Delirium tremens is usually understood to be a disease consequent upon the sottish or excessive use of alcoholic or fermented drinks." (Thomas Laycock, *Edinburgh Medical Journal*, October, 1858.)

"It seems to be forgotten that the disease is not occasioned by a fit of drunkenness, but that it is the result of the long-continued, excessive use of stimulants." (Alex. Peddie, *Journal of Medical Science*, 1854, p. 492.)

"To me it is apparent that habitual excess in the use of stimuli is alike the exciting and the predisposing cause of delirium tremens." (Same, p. 496.)

"This does not break out suddenly or after a prodromic stage of only a few days, as is often described. If we examine the antecedents of a person suffering from alcoholic delirium, we shall find that the outbreak of the delirium was brewing long before." (Tuke, *Dictionary of Psychological Medicine*, Art. 'Delirium Tremens.')

"Delirium tremens: a train of morbid phenomena, produced by the slow and cumulative action of alcohol, in the various forms in which it is used as a drink." (Aitken, *Science and Practice of Medicine*, vol. ii., p. 842.)

"Delirium tremens. It must be looked upon as an episode or epiphenomenon of chronic alcoholism. It is rare that even prolonged temporary excesses in persons ordinarily temperate are followed by delirium tremens." (Wilson, *Pepper's System of Medicine*, vol. v., p. 627.)

The last quotation is the only one that in any respect resembles that given by the learned justice. It seems to us that, even with this, it is hardly possible for a reasonable man to look upon an attack of delirium tremens as consistent with the statement of always being temperate. In this contention we have excellent judicial support, which ranks quite as high as the authority we are disputing. In the case of *Thomson* vs. *Weems*, L. R. 9 App. Cas. 671, this very decision was analyzed. Here also the statements of the insured were made express warranties. The questions in the application were, "Are you temperate in your habits?" "Have you always been strictly so?" The answers were, "Temperate," "Yes." The case was finally carried to the House of Lords, and it was there held as follows:

"The question must, in my opinion, be interpreted according to the ordinary and natural meaning of the words used, if that meaning be

plain and unequivocal, and there be nothing in the context to qualify it. On the other hand, if the words used are ambiguous they must be construed *contra proferentes*, and in favor of the assured. For my own part, I can discern no ambiguity in the language of question seven. I agree with Lord Rutherford Clark that 'the import of the answer is precisely the same as if the deceased had affirmed, first, that he was temperate in his habits, and secondly, that he had always been strictly so.' In its plain and ordinary sense, that statement is an averment of the fact, and not a mere assertion of the opinion or belief entertained by the assured with regard to the fact. It then appears to me that, whatever may be the import of the word 'temperate' (which is a separate matter), the assured must be held to have warranted, not that the assertion was true according to his sincere conviction, but true in point of fact; and consequently, that in order to establish a breach of warranty it is not necessary for the appellant to prove that the assertion was morally false. . . .

"An ingenious argument was addressed to your Lordships by the respondent's counsel, for the purpose of showing that the seventh question, from its very nature, involved only matter of opinion and not of fact, and consequently that any reply to it must be treated as an expression of opinion, and not as an assertion of fact. It appeared to me that their argument, which turned upon a very fine-drawn distinction between what were termed matters of pure fact and matters of opinion, had really no practical bearing upon the case before us. There are facts innumerable which can only be ascertained by the test of opinion, but they are not the less facts in a legal, whatever they may be in a metaphysical, sense. It appears to me to be in vain to contend that the character of a man's habits, temperate or intemperate, is a matter of opinion and not of fact. . . .

"I now come to the second question in this appeal, which, as I have already stated, is a question not of law but of fact. Was the late William Weems, on the 9th of November, 1881, and had he previously been, a man of 'temperate habits' as he then asserted? If that question must be answered according to the truth, and not according to the personal belief of the deceased, two of the judges of the Second Division were of the opinion that he was not. It does not clearly appear what view of the evidence would have been taken, upon that assumption, by Lords Young and Craighill; but I think the Lord Ordinary was prepared to hold, and did hold, that the deceased was, in point of fact, a man of temperate habits within the meaning of the seventh question. I entirely agree with many of the observations which were made by the Lord Ordinary in regard to what ought, for the purposes of this case, to be considered as constituting temperate habits, although, upon the evidence before us, I am unable to come to the same conclusion as his Lordship. I am disposed to think that the learned judge must have attached undue weight to the case of *The Knickerbocker Life Assurance Co. of New York* vs. *Foley*, 105 U. S. 350, in regard to the rubric of which his Lordship says: 'The law here stated is that which the Lord Ordinary adopts, and which he has endeavored to apply in his present judgment.' Now, as I read the rubric and report, there was no law laid down in that case. An American jury had found that a man was of temperate habits although it had been proved at the trial that he had an attack of delirium tremens; and the court refused to disturb the verdict, the main reason assigned for that

decision being a statement occurring in some treatise on medical jurisprudence to the effect that, in the case of an intemperate man, delirum tremens is occasioned by absence from drink, and in the case of a temperate man by indulgence in liquor. Even if it had been laid down as a matter of law, I should hesitate very much to adopt such a standard as that. A man suffering from delirium tremens occasioned by recent drinking may possibly be more temperate than another man who is similarly afflicted in consequence of his having abstained from his usual potations; but I should not like to affirm that either of them was, in the ordinary sense of the term, a man of temperate habits. . . .

"I believe it to be useless to attempt a precise definition of what constitutes 'temperate habits' or 'temperance' in the sense in which these expressions are ordinarily employed. Men differ so much in their capacity for imbibing strong drinks that quantity affords no test; what one man might take without exceeding the bounds of moderation another could not take without committing excesses. In judging of a man's sobriety, his position in life and the habits of the class to which he belongs must, in my opinion, always be taken into account, because it is the custom of men engaged in certain lines of business to take what is called refreshment, without any imputation of excess, at times when a similar indulgence on the part of men not so engaged would be, to say the least, suspicious. But I do not think that the habits of a particular locality ought to be taken into account, or that a man who would be generally regarded as of intemperate habits ought to escape from that imputation because he is no worse than his neighbors. In the present case the evidence clearly establishes that the assured was a most able and estimable man; but that circumstance is not of much weight, because able and estimable men are not necessarily exempt from social failings. . . .

"It seems to me to be the fair result of the evidence, that the assured was in the habit of taking more drink than was good for him; that he was frequently affected with drink on occasions when all except himself were sober; that his indulgence to excess had become so apparent that several of his friends had remonstrated with him on the subject, and that instead of repudiating the charge he admitted it and promised amendment. These facts appear to me to be fully proved, and they are, in my opinion, altogether inconsistent with the truth of the assertion that he was, on the 9th of November, 1881, of temperate habits and had always been so."

We have quoted this decision at considerable length, both because of its intrinsic excellence and also because it so ably maintains the view for which we are contending, namely, that an attack of delirium tremens is utterly irreconcilable with temperate habits.

5. In discussing intemperance from the medical point of view, it is hardly possible to give a definite statement as to what constitutes an "intemperate" man or "intemperate habits." In the Century Dictionary "intemperate" is defined as, "in a restricted sense, immoderate in the use of intoxicating drinks; given to excessive drinking." In a note "intemperate habits" are referred to as the "habitual and excessive indulgence in the use of alcoholic drinks." This, of course, carries us no nearer our goal, for we must define "immoderate" and "excessive." At the same time it shows that there is a distinction between "intemperate" and "habits

of intemperance," and the distinction is popular and common. It has been our invariable custom for some years past to ask applicants for insurance if they have "always been temperate." The answers are frequently like this: "I have never been drunk in my life;" or, "Well, I have been drunk once or twice, but very seldom." These answers, we think, show very clearly that the laity understand the question to refer to ordinary intoxication, and not to habits of intemperance. But this latter is the judicial construction in the case of *Fox* vs. *Life Insurance Co.* (p. 544), and of *Life Insurance Co.* vs. *Reif* (p. 545).

The limits within which temperance can range vary greatly. It certainly does not mean total abstinence. On the other hand, it does not mean the use of alcoholics to such a degree as to give rise to delirium tremens, or to cause some pathological lesion which is traceable directly to the alcoholic poison, such as hepatic cirrhosis. But at what point between these extremes can temperance be said to merge into intemperance? Where shall we draw the line? It cannot be said that an occasional "drunk," once or twice a year and lasting only a night, constitutes intemperance. How many, then, will it take to convert a sociable fellow into an intemperate one? Is this infrequent spreeing incompatible with a warranty of always "temperate"? On the other hand, can a man be intemperate without getting drunk? This latter is certainly possible. A man can distribute over the day and evening eight or ten drinks of whiskey, amounting to five or six ounces, and representing two or three ounces of alcohol, so that at no time can he be said to be intoxicated. But that truly constitutes intemperance, and one of its worst forms.

The physiological capacity, so called, for alcohol is set by Anstie at one and a half to two ounces of alcohol per diem. Parke (*Practical Hygiene*, vol. i.) indorses this view after a fashion. He says that the limit of the useful effect of alcohol is produced by a daily quantity of one to one and a half ounces; that more than this is certainly injurious, and it is better to use light wines than liquors, or even beer. He concludes by saying that "the facts now stated make it difficult to avoid the conclusion that the dietetic value of alcohol has been much overrated. It does not appear possible to condemn alcohol altogether as an article of diet in health or to prove that it is invariably hurtful, as some have attempted to do. It produces effects which are often useful in disease, but in health it certainly is not a necessity, and many persons are much better without it." Even these small amounts of alcohol unquestionably have an influence on the prospects of longevity. But after all, an average risk, that has sound health and good antecedents, is all that an insurance company can ask for. Hence moderate drinking does not impair their calculations by introducing an element of greater risk, for it is already reckoned in the average. But, as we shall see later, any excess has so deleterious an influence that cases subject to it must be carefully excluded. Does any one imagine that any of the cases mentioned under section 4 would be accepted by any reputable life insurance company if the applicants had told the truth with even approximate accuracy?

The statistical work on this subject does not reach large proportions. The earliest calculations that we could find were by F. G. P. Neison (*Contributions to Vital Statistics*, 1857) when he made a study of intemperance by means of circulars inclosing a carefully prepared schedule

of questions. In this way he obtained the records of 357 cases. In the circular he stated that the cases must be those of persons who were "decidedly addicted to drinking habits during a considerable period of life." No more exact definition of intemperance was adopted, since, as he very justly remarks, "the consequence of following this course is, that the objections which might be urged against the adoption of any individual or peculiar test are avoided, for, by leaving it to each contributor of data to determine for himself what constitutes decidedly intemperate habits, the whole data, taken collectively, from all the various contributors, will show very clearly the result of those habits which the public, by common consent, admit to be intemperate; so that, however any individual reasoner on the results may argue, and whatever peculiar construction he may choose to put upon them, it will be impossible to avoid the conclusion that the data really relate to what the public generally regard as persons of intemperate habits." In one table he compares the general mortality percent. of England and Wales with that of intemperate persons, as follows:

Age.	*Mortality percent. of intemperate persons.*	*Mortality percent. of England and Wales.*
16 to 20 years................	1.342	.730
21 to 30 years................	4.953	.974
31 to 40 years................	4.620	1.110
48 to 50 years................	5.992	1.452
51 to 60 years................	6.418	2.254
61 to 70 years................	7.992	4.259
71 to 80 years................	18.182	9.097
81 to 90 years................	20.000	19.904

In only 65 out of these 357 cases was the cause of death assigned directly to intemperance. In another table he states that the number of deaths assigned to delirium tremens and intemperance in England and Wales in 1847 amounted to only 731 out of a total of 228,780. This shows how insignificant a proportion of deaths can be directly ascribed to intoxicants. The basis of these tables is open to some criticism in that the number of cases is very small from which to draw any reliable conclusions, and the kind of intemperance called for is excessive. Besides, the ordinary drinking habits in those days were considerably larger than at present. Hence, if the cases were of persons "decidedly addicted to drinking habits," they would rank still lower in the scale at the present time.

From this report it will be seen that intemperance infrequently causes death directly, but its influence is felt over a wide range of diseases. In fact, its manifestations are most marked in its unfavorable effect on the prognosis of disease in general. But it is just this deleterious influence which is apparently overlooked in such decisions as that in the case of *McGinley* vs. *Life Insurance Co.* (see p. 543).

Bearing upon this indirect influence of alcoholics is the report of a committee to the Harveian Society (*British Medical Journal*, 1883, vol. i., p. 100.) About ten thousand lives were used in the construction of a table, from which the following conclusions were drawn:

"We find, therefore, upon the whole, reason to think that, in the metropolis, the mortality among any considerable group of intemperate per-

sons will differ from that generally prevailing among adults in the following important particulars, viz.: a fourfold increase in the deaths from diseases of the liver and chylopoetic viscera; a twofold increase in the deaths from diseases of the kidneys, a decrease of half as much again in those from heart disease, a marked increase in those from pneumonia and pleurisy, a considerable increase and an earlier occurrence of those from disease of the central nervous system; a marked decrease in those from bronchitis, asthma, emphysema, and congestion of the lungs, a decrease nearly as great from phthisis, and a later occurrence, or at least termination, of the disease; a very large decrease in those from old age, with an increase in those referred to atrophy, debility, etc., and the addition of a considerable group, referred in general terms to alcoholism or chronic alcoholism, or resulting from accidents."

In 1888 a collective investigation committee of the British Medical Association made a report (*British Medical Journal*, 1888, vol. i., p. 1316) on 4234 cases, with reference to the influence of habits on the duration of life and the cause of death. The cases were divided into five classes, viz., total abstainers, habitually temperate, careless drinkers, free drinkers, decidedly intemperate. Among the conclusions the following have relation to the subject under discussion:

"1. That habitual indulgence in alcoholic liquors beyond the most moderate amounts has a distinct tendency to shorten life, the average shortening being roughly proportioned to the degree of indulgence. . . .

"3. That in the production of cirrhosis and gout alcoholic excess plays the very marked part which it has long been recognized as doing. . . .

"4. That, cirrhosis and gout apart, the effect of alcoholic liquors is rather to predispose the body toward the attacks of disease generally than to induce any special pathological lesion. . . .

"6. That there is no ground for belief that alcoholic excess leads in any special manner to the development of malignant disease, and some reason to think that it may delay its production.

"7. That in the young alcoholic liquors seem rather to check than to induce the formation of tubercle; while in old age there is some reason to believe that the effects are reversed."

Some life insurance companies require abstinence of their policy-holders, or divide them into two classes, abstainers and non-abstainers. Not many of these companies have published their results, but what has been told bears out the argument so far advanced by us. Thus, the comparative mortality of the two sections in the United Kingdom Temperance and General Provident Institution for the nine years, 1866–74, is as follows:

	Expected Mortality.	*Actual Mortality.*	*Ratio.*
General section..............	2002	1977	98.80
Abstinence section...........	1111	801	72.16

It is presumed, of course, that the usual precautions were taken to exclude persons of intemperate habits from the general section.

Opium and Allied Narcotics.—The influence of the habitual use of these drugs is usually considered harmful, and some question relating to them is always put in the application. It does not seem proper that this should include the infrequent administration of them for medicinal purposes only, and regularly with the advice of a physician. This would

be straining a point, and we think it would be justly so considered in any court of law. Of course, the question arises as to what would constitute a breach of warranty in this respect. Here we are confronted with the same difficulties which were present in the case of alcoholics. Fortunately, there are fewer decisions and consequently less confusion.

Does the presence or absence of a physician's order help us in laying down a rule? It is with some diffidence that we advance the proposition that, in the absence of a physician's mandate, the use of opium or other narcotics would amount to an improper use of these substances, and hence would be included within the spirit and intent of a question referring to the use of these drugs. As a general rule, it may be said that such cases are rejected by life insurance companies if the facts are told to them in making application. It is true that there are the occasional exceptions of the man who, at very infrequent intervals, takes some favorite mixture for an attack of insomnia without consulting his physician, or of the man who relieves his very infrequent enteralgia in the same way. But both the narcotic and the need for taking it militate strongly against his acceptance by any good life insurance company. Such being the case, it seems only fair to apply the same rule even if the policy has already been issued. It may be argued that the applicant does not attach the same importance to the subject that the company does. If the question is plainly put, there can certainly be no plea of ignorance, as there might be if it were some latent disease. It is not for the applicant to judge of the importance of a question; it is his business to answer it as fully as he can, and with the utmost good faith. If he states the facts, and the company then decides to accept him, he is relieved of all responsibility in the matter. We fear, however, after considering the liberality of judicial construction in such matters, that our opinion would not be the one adopted. But where the courts would draw the line we cannot tell, as there are no decisions on the subject. On the other hand, the prescription of a physician to take any one of these drugs should secure exemption to the individual from telling the fact, unless the treatment had been long continued or recent.

There is another phase of this subject which must be considered. In many of the old policies and some of the new there is no direct question asked with reference to these narcotics. Consequently the attention of the applicant is not drawn to the subject. In all of them, however, there is some general declaration to the effect that the applicant is concealing no material fact from the insurer, or is doing nothing in any way to shorten his life. Hence arises the question, Is the existence of a habit of this kind a material fact? Does it tend to shorten life? To answer this question properly it would be necessary to have data as to the effect of each of these narcotics on longevity. Exhaustive information on these points, however, is unfortunately not to be had. Opium alone has been the object of some observation in this respect. It is the common belief that the chronic use of this drug tends decidedly to shorten life, but when we came to look up the literature on this point we were surprised at the dearth of positive information. The organic lesions that it produces are almost nil. It does cause a chronic gastro-intestinal catarrh, considerable anæmia, and general malnutrition, and occasionally some albuminuria. The latter, however, according to Bancroft (*Reference Handbook of the Medical Sciences*, vol. v., p. 328), is always

functional, for it entirely disappears after the use of the drug is discontinued. All the other effects of the drug are exerted upon the nervous system, but in only a small proportion of cases does its use lead to sufficient mental alienation to amount to insanity. Tuke (*Dictionary of Psychological Medicine*, vol. ii., p. 820) says: "The prognosis of morphiomania as a disease is most unfavorable; it terminates sooner or later fatally by general marasmus. A certain number of patients become insane, while others commit suicide."

Osler (*Practice of Medicine*, p. 1006) says: "Finally a condition of asthenia is induced, in which the victim takes little or no food, and dies from the extreme bodily debility."

Levinstein (*Morbid Craving for Morphia*, p. 108) makes practically the same statement. But, after all, these are only "glittering generalities," and it must be remembered that these men only come in contact with the worst cases. On the other hand, we have a great deal of testimony that the habit can be indulged in to a considerable extent and for a long time with no apparent detriment to the general health. In the famous case of the Earl of Mar it was proven that he had been in the habit of taking laudanum for thirty years, sometimes as much as two or three ounces daily. At this trial there were many examples of persons adduced who had taken opium without evil effects for many years. While the testimony of the experts was that the habit tended to shorten life, they could give no examples of that result.

In India, if we can accept the testimony of the British medical officers there stationed, the moderate use of opium is in no marked particular harmful. This is very elaborately considered in the *British Medical Journal* (Dec., 1893, Jan. and Feb., 1894) in the analysis of over one hundred reports from medical officers and civilians resident in India. The abstract states that the moderate use of opium, meaning thereby from two to eight grains daily, was directly beneficial as a prophylactic against malaria, diarrhœa, dysentery, and cholera, and that in no case were its evils as great as those of alcohol. Most of the reports were to the effect that opium smoking was injurious, although they did not indicate in what way. As regards the dangers of the opium habit in India, Sir Joseph Fayrer (*British Medical Journal*, 1893, vol. ii., p. 1195) says: "It is said, I believe, by its opponents, that the tendency to opium eating is ever to increase, to induce, it may be, slow but sure degradation and destruction. I do not believe this. In the course of many years' experience in India I have known so many who have been habitual consumers of a small quantity of opium, without in any way suffering from it, or without any tendency to increase the habit, that I am unable to agree with those who state otherwise. . . . It seems to me that this crusade against opium, though well meant, is not reasonable. It is as unfair to argue from the habitués of opium-smoking houses as it is from the frequenters of gin palaces and other haunts, where the most degraded forms of alcoholic abuse may be met with in our own country. Both, in extreme cases, are an evil; but the moderate use, either of alcohol or of opium, must be left to the discretion of those who feel called upon to take them."

On the other hand, the very different status of the opium habit in this country must be remembered. In India it is openly indulged in, and opium seems to take the place of both alcohol and tobacco. Here its use

is a secret vice, practiced chiefly by those whose will-power is in abeyance, either on account of some painful disease or by heredity. The most insidious method of use is commonly adopted here, that of hypodermic injection. Like all other secret vices, there is a constant tendency to take larger amounts, and this inclination is here usually gratified, contrary to the experience in India. Hence we can only say that it is not fair to apply the same rules to the habit here and in India. But owing to the entire absence of statistical information, we are unable to say what effect it has upon the duration of life. It would seem to us, however, to be a material fact, the existence of which should be communicated to the insurer, for him to act upon as he wishes.

Similar remarks must apply to the chloral habit and other forms of drug addiction. So far as we know, they do not give rise to any organic changes, but all the testimony we have is to the effect that they are decidedly harmful, and have a marked tendency to shorten life. The existence of any of these habits, present or past, is a material fact, which must be communicated to the insurer.

Family Record.—Heredity plays a very important part in some diseases, and is regarded of so much consequence that insurers regularly ask for the family history with considerable detail. Many applicants for insurance are rejected simply on their bad family record. The age of the relatives does not count for so much as their state of health, if living, or the cause of their death. While many diseases may be due to some extent to heredity, only those in which this influence is more pronounced are specifically mentioned in the applications. These usually include insanity and other nervous diseases, gout, rheumatism, consumption, scrofula, and cancer. And in this connection the statement that the cause of the mother's death was childbirth always casts a cloud on the risk. It is held that name usually is simply a disguise for phthisis. Even where the duration of the illness is stated to be short, it is probable that the exhaustion of parturition has brought to a sudden close the chronic disease. This has long been a belief among insurance examiners, and it is supported by the actual results. H. W. Manley (*Journal of the Institute of Actuaries*, vol. xxx., p. 97) made a careful investigation of this point. Out of 83 persons whose mothers only had died of consumption, there was an actual mortality of 22 against an expected mortality of 17.570 by the HM. Table; that is to say, the mortality was 25.2 percent. in excess of the expected. Out of 226 persons the death of whose mothers was ascribed to childbirth, the actual mortality was 68 against an expected mortality of 53.086; that is to say, the actual mortality was 28.1 percent. in excess of the expected. The influence of a consumptive mother made the mortality 25 percent. greater than was reasonable to expect, while the death of the mother from childbirth made it 28 percent. greater. On comparing the causes of death in the two sets of cases it was noticed that tuberculosis bore nearly the same proportion in each, being 18 percent. in the former and 16 percent. in the latter.

In the case of *Baker* vs. *Life Insurance Co.*, 4 Bigelow's Life and Acc. Rep. 355, the insured gave a negative answer to the question, "Have the parents, uncles, aunts, brothers, or sisters of the party been afflicted with insanity, or with any pulmonary, scrofulous, or with any other constitutional disease?"

It was proven beyond doubt that at least one brother had died of con-

sumption and probably others. It was held: "It is true, the twentieth question is very far-reaching. And the answer to it, being an unqualified negative, was a very incautious and dangerous assertion, but it is not for the court to alter the plain contract of the parties."

In the case of *Insurance Co.* vs. *Gray et al.*, 91 Ill. 159, the insured gave a negative answer to the question, "Have either of your parents, brothers or sisters, ever had any pulmonary, scrofulous, or any mental or constitutional or hereditary disease?"

On appeal it was held: "The evidence that both parents died of pulmonary consumption, of which they each suffered for several years before their respective deaths, is all one way. It is proved by relatives, neighbors, and physicians, and it is not reasonable to assume that the assured was even ignorant of this fact, for he seems to have been living with or near his parents during the time they were thus afflicted. There is no effort to prove that either of them died of a fever, or were even sick of a fever. The disease of which they died is generally believed to be hereditary, and it is impossible to escape the conviction that the truth here was withheld because its communication would either have defeated the application for the policy or materially increased the premiums for the risk."

In the case of *Insurance Co.* vs. *Gridley*, 100 U. S. 614, to the question, "Have the person's [whose life is to be insured] parents, uncles, aunts, brothers, or sisters been afflicted with consumption, scrofula, insanity, epilepsy, disease of the heart, or any other hereditary disease?" the assured answered, "No hereditary taint of any kind in family on either side of house, to my knowledge."

It was proven, on behalf of the company, that an uncle of the insured was insane for more than a year, and that he died in an asylum, twenty years before the application for insurance. And it was argued that on this ground a verdict should be rendered for the company. It was not, however, and on appeal it was held: "To make out the defense sought to be established by the insurers, three things were, therefore, necessary to be shown: that the alleged insanity of the uncle had existed; that it was hereditary; and that both of these things were known to the applicant when he answered the question. The first point was clearly proved. In relation to the second and third there was no proof whatever. What was proved, without what was not proved, was of no account. The defense, therefore, wholly failed." This seems very reasonable, as the defense, on its face, is only a quibble.

Here there was a proper indication for the use of the term "hereditary." In some cases, however, it seems to be confounded with the term "inherited." The definition of "hereditary," according to Webster, is, "Transmitted, or capable of being transmitted, from a parent to a child; as, hereditary disease." Except for its narrow limitations to lineals only, this definition is exactly what the insurer means. The insurer does not care to know about diseases which are already transmitted to the applicant, for in that case his physical condition is already such as to warrant his rejection. But the insurer does wish to know about diseases in the family which are capable of being transmitted, and which may break out in the usual way at any time. To say in effect that the disease must be inherited is absurd, for, to make a bull, it cannot be proved that it is an inherited disease until it has been inherited, i.e., developed. This view, however,

was the one apparently taken in the case of *Sinclair* vs. *Life Insurance Co.*, 9 Ins. L. J. 523. Here the insured gave a negative answer to the question, "Have the parents or brothers or sisters of the party been affected with insanity, or with pulmonary, scrofulous, or any other constitutional disease hereditary in its character?" It was proven that the father and sister had died of consumption. The family physician said he did not know whether it was hereditary or not, but that he did not think that it was. It was held that it must be proven that it was "hereditary in its character," in order to come within the question above mentioned. The judge said that "the undoubted object of that question was to procure information as to whether insanity, scrofulous and pulmonary diseases had developed in an hereditary form among the relatives of the applicant." That is true; but the question did not state that the disease must be an inherited one. Consumption is an hereditary disease, and in about one half of the cases we can get evidence of its diathesis having been inherited from the progenitors or the collaterals of the individual. The accidental development of the other fifty percent. does not preclude consumption from being an hereditary disease. The question does not refer to a particular instance, but does ask if the individual ever had any hereditary constitutional disease. How many generations does it take to make an hereditary disease? The medical testimony admits of strong criticism on this point.

A somewhat different criticism must be made in the case of *Peasley* vs. *Life Insurance Co.*, 15 Hun 227. Here the insured gave a negative answer to the question, "Have the party's parents, uncles, aunts, brothers, or sisters been afflicted with consumption, scrofula, insanity, epilepsy, diseases of the heart, or other hereditary disease?"

It was proven that the mother of the insured had had three attacks of insanity, in each case apparently due to accidental causes, such as a fever or displacement of the uterus. Although the statements were warranties, it was held that the last three words of the question qualified all the others, and were intended to show that the diseases mentioned must be the product of heredity.

This definition was right; but does not the development of such a disease indicate a weakness of the system which is capable of transmission to the offspring, and hence hereditary? Hereditary does not mean necessarily inherited. An outbreak of insanity must rarely occur in women solely as the result of a displacement of the uterus unless there is associated with it a latent capacity for mental alienation. If it did, there are few of our women who would not be in an asylum at some time of their lives. Then this inability to resist nervous strain, being the foundation of the insanity and being hereditary, would not the insanity itself be considered hereditary?

Occupation.—It is well known that the rates of mortality vary greatly according to the occupation. Some occupations are so hazardous that no company will take persons engaged in them. In the case of others less dangerous, the company may issue a policy, but obliges the insured to take the risk of death from any accident which is incident to the occupation. In still others the company assumes the whole risk, but charges an extra premium. The following table shows the relative mortality in the more common occupations. It represents the number of deaths occurring in each occupation between the ages of twenty-five

ıd sixty-five, as compared with a normal standard of one thousand deaths the general population during these years. (*Medical Handbook of Life ssurance*, by Pollock and Chisholm, p. 206 et seq.)

PROFESSIONAL MEN.

Clergyman	556
Schoolmaster	719
Barrister	842
Artist	921
Physician	1122
Musician	1314

MERCHANTS.

Coal merchant	758
Bookseller, stationer	825
General shopkeeper	865
Ironmonger	895
Fishmonger, poulterer	974
Tobacconist	1000
Cheesemonger	1009
Chemist, druggist	1015
Greengrocer, fruiterer	1025

MANUAL WORKERS.

Gardener, nurseryman	599
Farmer	631
Agricultural laborer	701
Fisherman	797
Carpenter, joiner	820
Baker, confectioner	958
Builder, mason, bricklayer	969
Tailor	1051
Printer	1071
Stone, slate-quarrier	1122
Cutler, scissors-maker	1309
File-maker	1667
Earthenware manufacturer	1742

OCCUPATIONS PARTICULARLY SUBJECT TO INTEMPERANCE.

Butcher	1170
Brewer	1361
Cab, omnibus service	1482
Inn-keeper, publican	1521
Costermonger, street-hawker	1879

While the courts are quite strict in their construction of the statement the insured as to his occupation, they will accept no quibbling defense ı the part of the company, as the following cases show. In the case of *ife and Accident Co.* vs. *Burroughs*, 69 Pa. St. 43, the insured stated in s application that he was an earthenware manufacturer. His death as due to peritonitis, caused by an accident while working in a hay ld. It was proven that he was on a visit to his grandfather and was lping him in the haying. The court held that this constituted no ange of occupation.

A similar ruling was given in the case of *Stones' Administrators* vs. *ısualty Co.*, 34 N. J. L. 371, where it was held that: "A teacher who has home in the course of erection may visit said house as a spectator, without doing anything which is aside from the ordinary line of his life."

Again, in the case of *Tucker* vs. *Life Insurance Co.*, 50 Hun 50, there was a clause forbidding employment in "mining, blasting, or wrecking." The insured met his death by drowning, while saving the crew of a schooner which had been driven ashore near his farm. The court held that: "He was a farmer, and not, by occupation, a wrecker. As well might a farmer who should be smothered in attempting to rescue his neighbors from their burning dwelling be called a fireman, as this man a wrecker." This was indorsed in 121 N. Y. 718.

Similarly, in the case of *Grattan* vs. *Life Insurance Co.*, 80 N. Y. 281, it was held that there was no material difference between a soda-water maker and a soda-water peddler.

On the other hand, where there is any suspicion of fraudulent concealment the decisions are very severe against the insured. Thus, in the case of *Hartmann* vs. *Life Insurance Co.*, 21 Pa. St. 466, it was held: "If the insured, who represented himself to be a farmer, was in fact a slave-taker by occupation, and if the business of slave-taking would expose his life to greater danger than farming, it is not possible to escape the conclusion that the policy was thereby rendered void, since, if it was willfully made, it was a fraud; and though made ignorantly, or by mistake, it was a warranty by the express terms of the policy. . . .

"The court very properly charged that the occupation of the insured, which his duty required him to disclose, was that business which he was engaged in at the time he made his application. If it meant the trade he learned in his youth, and which he had followed years before, it would indeed be immaterial whether he told the truth or a falsehood, and it would have been mere folly in the insurers to ask him the question."

Again, in the case of *Aid Society* vs. *White*, 100 Pa. St. 12, the insured stated in his application that he was a laborer, but it was proved that he had done no work at all for several years. The Appellate Court held that it was an error to charge: "We, therefore, instruct you that the answer 'laborer' in evidence shows that Murray was a laborer in former years, and covers the question in the application." It was also stated that a merely temporary suspension of the alleged occupation would not constitute a breach of warranty, but that a suspension extending through a number of years would.

This was apparently the view taken in the case of *Mowry* vs. *Life Insurance Co.*, 7 Daly 321. The insured stated in his application that his occupation was "manufacturing." It was held that the fact that he was keeping a billiard saloon at the time of the application did not constitute a breach of warranty, for he had been for many years engaged in manufacturing soda-water and expected to resume that business in a few days. This is a very liberal extension, and is susceptible of great abuse. The company itself, however, was partly responsible, since it accepted this answer as being a sufficiently definite statement of his business.

A more rigid rule was laid down in the case of *Fitch* vs. *Life Insurance Co.*, 2 N. Y. Sup. Rep. T. and C. 247. In the application made in 1870, the applicant was asked to state his vocation, what it was, and what it had been, and his answer was, "Traveling agent." It was proven that he was in the army in 1864 and 1865, and had been a painter before and after that time until 1867.

"His answers, too, in respect to his vocation, and where he had lived since his birth, contained covert falsehoods, which, if not intended to de-

ceive, were likely to do so. The inquiry as to his vocation was what it then was and what it had been. His answer, 'Traveling agent,' was true as to what it then was, but untrue as to what it had been; for the inquiry as to his past vocation obviously called for the statement that he had been a painter and a soldier as well as a traveling agent. The answer was false from the clear and manifest failure to tell the whole truth." This ruling was reversed in 59 N. Y. 557, chiefly on the ground that the statements of the insured were representations only, and not warranties.

One of the most common phases of this subject to be decided arises from the applicant's answer to the question whether he is engaged in the occupation of selling liquors. The form of question used for eliciting this information varies so much that no fixed rules can be deduced from the determinations of the courts. Generally it may be said that if the questions as to the liquor-selling are clearly put by the company, the courts will construe as material and fatal any falsity in the answer. Thus, in the case of *Dwight et al.* vs. *Life Insurance Co.*, 100 N. Y. 341, the insured gave a negative answer to the question, "Is he now or has he been engaged in or connected with the manufacture or sale of any beer, wine, or any other intoxicating liquors?" It was proven that the insured had kept a hotel for three years, and had sold wines and liquors to his guests, although there was no bar in the hotel. It was held that this constituted a breach of warranty.

On the other hand, the courts will here, as elsewhere, give the insured the benefit of any construction of the contract that may be possible. In the case of *McGurk* vs. *Life Insurance Co.*, 56 Conn. 528, a correct definition was used with telling effect against the company. The insured stated in his application that he was a "grocer." It was proven that he sold liquors freely in his store, but it was held that: "Webster defines the meaning of the word 'grocer' to be 'A trader who deals in tea, sugar, spices, coffee, liquors, fruit, etc.' The word, therefore, properly describes McGurk's occupation, and nothing whatever appears in the case tending to show any want of sincerity on his part in his answer, much less that by it he committed a fraud on the defendants which made void the contract of insurance in its inception. He doubtless believed at the time that the word 'grocer' covered his entire occupation." This ruling seemed for a moment incorrect, but the Century Dictionary bears out Webster, and we remember that we have hardly ever seen a country grocery where liquor was not sold.

A very fine point was decided in the case of *Kenyon et al.* vs. *Aid Association*, 122 N. Y. 247. The insured was asked: "Profession or occupation? State previous nature of business.

"*A.* Importer and wholesale dealer in wines and liquors.

"*Q.* Is the person engaged in any way in the retailing of alcoholic liquors?

"*A.* No; keeps no bar and sells only at wholesale; have government license and town license."

These answers of the insured were regarded as strict warranties. It was proven that he sold by measure and bottle, in quantities less than five gallons, but not to be drunk on the premises. It was held that this was not incompatible with his statement that he was a wholesale dealer, in view of the elaborate explanation he had made in the next answer; that he intended to convey the idea, and did convey it, that he did not

sell liquor to be drunk on his premises; and that the company, having accepted his application with this explanation, must stand by it.

Residence.—A company will either decline to insure applicants in a locality which they know to be unhealthy, or else will, when insuring, charge a higher premium, sufficient to cover the increased risk. In order, therefore, to prevent persons who are insured in healthy regions from moving into unhealthy localities, clauses are inserted in the policy restricting the right of travel and residence. In former times these restrictions were quite complicated, and extended over the whole life of the policy. Of late years they have been much simplified, and usually apply to the first year or two only. These clauses are generally interpreted quite rigidly by the courts, but in one of the earliest cases, *Baldwin* vs. *Insurance and Trust Co.*, 3 Bosworth 530, a liberal rule was laid down. The insured was forbidden to visit "those parts of the United States which lie south of the southern boundaries of Virginia and Kentucky." He received a permit "to travel anywhere in the United States, but must be north of the south boundary of Virginia by July 10, 1854." He was taken sick in Appalachicola, Fla., on June 11th, was too sick to be moved, and died there on July 20th. It was held that the contract was not void, for the disability to perform the condition was the act of God, and occurred without any default or neglect on his part.

This opinion was overruled in the case of *Evans* vs. *Life Insurance Co.*, 64 N. Y. 304, on a permit of a similar character. The insured made no effort to return, it is true, but the court held that "another answer to this claim [that it was the act of God] is, that he took the chances of being able to return. He went south for business purposes, knowing that the policy would be avoided if he did not return by the 1st of July."

A similar decision was rendered in the case of *Nightingale et al.* vs. *Insurance Co.*, 5 R. I. 38. Here the insured between July 1st and October 15th was not allowed to be in any portion of the United States, outside of certain named States, more than five days without a permit. He went to Maryland, which was outside the permitted limits, and stayed there ten days, when he died of apoplexy. This disease had no relation to the climate or the country, but the court held that that made no difference, and the policy was void according to the terms of the restriction. This case seems particularly severe, as the insured was the Bishop of Rhode Island, who was called to Maryland on account of the illness and temporary absence of the Bishop of Maryland, to attend to some of his canonical duties, and also because the fatal disease was in no sense due to the climate or the voyage. The court probably construed the proviso so rigidly because a permit to extend his time beyond five days could easily have been obtained by the insured.

A reminiscence of the days when we had a frontier is brought out by the case of *Casler* vs. *Life Insurance Co.*, 22 N. Y. 427, where the courts held by five judges against three that the term "settled limits of the United States" did not mean the region of the settlements, but referred to the established boundaries of the United States, including in this both States and Territories. This case was decided in 1860.

Restrictions as to the routes to be traveled in going from one place to another must be followed very closely. Thus in the case of *Hathaway* vs. *Life and Fire Insurance Co.*, 11 Cush. 448, the insured was permitted "to make one voyage out and home to California, in a first-rate vessel

around Cape Horn or by Vera Cruz." He went to California, was taken sick, and returned home by way of Panama. There was no usually traveled route then by way of Vera Cruz, and the one chosen was the safest and shortest. But the court held: "It is of no consequence that the route taken home by the assured was, or may have been, as the plaintiff offered to prove, the safest and shortest. The policy excluded him, if he would avail himself of the provisions and of the assurance contained in it, from being governed by what was advisable and expedient. It fixed the terms upon which the promise should be binding, and upon which it should be annulled. By these terms the parties are bound. There having been a breach of the condition, the contract is thereby rendered void."

The "glorious days" of Bill Tweed and the still brighter days of his downfall are recalled in the case of *Douglas et al.* vs. *Life Insurance Co.* 83 N. Y. 492. Tweed took out a policy in 1868 which contained the restriction that the insured should not, "without the written consent of this company, previously obtained, travel upon the seas except in voyages between coastwise parts of the United States." As is well remembered, Tweed was arrested and sent to jail, but escaped from custody on September 4, 1875. He was not found until September, 1876, when he was recaptured at Vigo, in Spain. Needless to say, he had not obtained the consent of the insurance company for this little trip. They very properly and successfully resisted payment on this technical point. Had it been any one but a notorious criminal, who broke the conditions of his policy in violation of the law, it is more than likely that no question would have been raised about the settlement of the claim by the company.

In the case of *Pohalski* vs. *Life Insurance Co.*, 36 N. Y. Sup. Ct. 234, there were the usual restrictions in the policies issued at that time, forbidding the insured to pass outside of the United States and Canada. The insured had business in Havana, and obtained the following permit without extra charge: "Permission is hereby given to J. M. Pohalski to proceed to Cuba, and return before April 1, 1871. He to take his own risk of death from epidemics." He went to Cuba and died there in February, 1871, of yellow fever. Payment of the policy was resisted on the ground that yellow fever belonged to the class of diseases known as epidemics. It is most likely that this was the idea that the insurers had when the permit was given. But the referee found that, as the word was ordinarily used, it referred to a condition of a disease, in which the number of cases of that disease were so great that it might be called generally prevalent. He found that yellow fever was endemic in Havana at the time of insured's illness there, but not epidemic; in fact, it seemed probable that the cases which occurred there during that time might be called sporadic, so infrequent were they. We think this a very proper verdict under the circumstances. The permit was so loosely drawn that on its face it had no other meaning than the one given above. The attempt was made to introduce parol evidence that between the parties it had the interpretation which the defendants desired, but this was successfully resisted. The case was then carried to the Court of Appeals and judgment affirmed (56 N. Y. 640).

Age.—The question of age is one of fundamental importance in life insurance, for upon it depends the amount of the premiums to be paid, except in some assessment companies. Furthermore, it is of prime con-

sequence in the medical selection of some cases. In many companies it is the rule not to take applicants, one of whose parents has died of consumption, before they have reached a fixed age, usually thirty or thirty-five years. In the case of women an extra premium is usually charged during the child-bearing period, the limit of which many companies fix arbitrarily at a certain age, about forty-eight or fifty. For these and many other reasons it is necessary to know the age exactly. Many companies, especially in Europe, require certificates of birth before they issue a policy. As a man may not know his age, it is sometimes necessary to obtain collateral evidence. In the case of *Splents* vs. *Lefevre*, 11 L. T. N. S. 114, it was held that a family Bible was not good evidence as to age, unless it was also proven that the dates therein were made by some living member of the family, or were known to be made by some dead member.

As it is a matter of simple fact, the courts have usually been very strict in their decisions upon this point. Thus in the case of *Swett* vs. *Relief Society*, 78 Me. 541, the applicant stated his age to be fifty-nine, when in reality it was sixty-four, and was so proven. It was held that "the age of the applicant was a material fact. . . . His representation of the fact was a warranty of its truth, and if not true, the contract was invalid. This rule is so uniformly held by the courts that no authorities need be cited."

A similar conclusion was reached in the case of *Life Insurance Co.* vs. *France et al*, 91 U. S. 510, and in the case of *Ortlieb* vs. *Insurance Co.*, 4 Ins. L. J. 311.

On the other hand, the company may, by carelessness, inadvertence, or the faulty conduct of agents, lose its right to set up a claim of breach of warranty as to age. Thus, in the case of *Morrison* vs. *Life Insurance Co.*, 59 Wis. 162, the insured had one policy in this company, and then took out another. In this one he put his age at ten years younger than in the correct previous policy. Five years later he took out a third policy, in which he now again stated his age correctly. The company continued to receive assessments on all these policies for two more years, when he died. It was held that his misstatement in the second policy had been waived by the company.

A similar result was reached in the case of *Miller* vs. *Life Insurance Co.*, 107 N. Y. 292, where it was proven that the insured was seventy-three instead of sixty-four, as was stated in the application. It was also proven that the insured was a German who knew but little English; that when he was asked his age by the agent he said he did not know; that the agent made some computation as to his probable age and inserted this, which was apparently largely a guess, into the application. The court held that under the circumstances the company was estopped from setting up the falsity of this statement, as it was in reality the statement of its own agent.

Other Insurance.—The question is asked by most companies whether the applicant has been insured in other companies, and for what amounts. This is not a theoretical consideration, or mere inquisitiveness on the part of the company. It is proper for them to know it, for, if a man is taking insurance beyond his means, the knowledge will put them on their guard and cause more searching inquiries as to the reasons for the heavy insurance. And in many cases it might well cause them to refuse the

risk altogether, on the ground of the financial hazard. Therefore, the question should be answered quite closely and accurately. In the case of *McCullum* vs. *Life Insurance Co.*, 55 Hun 104, 106, it was even held that benefit and accident associations were included under the term insurance company in the question as to other insurance.

The law on this point was very clearly announced in the case of *Jeffries* vs. *Life Insurance Co.*, 22 Wall. 47: "The company deems it wise and prudent that the applicant shall inform it truly whether he has made any other application to have his life insured. So material does it deem this information that it stipulates that its liability shall depend upon the truth of the answer. The same is true of its inquiry whether the party is married or single. The company fixes this estimate of its importance. The applicant agrees that it is thus important by accepting the test. It would be a violation of the legal rights of the company to take from it its acknowledged power, thus to make its opinion the standard of what is material, and to leave that point to the determination of a jury. The jury may say, as the counsel here argues, that it is immaterial whether the applicant answers truly, if he answers one way, to wit: that he is single or that he has not made an application for insurance. Whether a question is material depends on the question itself. The information received may be immaterial, but if under any circumstances it can produce a reply which will influence the action of the company, the question cannot be deemed immaterial. Insurance companies sometimes insist that individuals largely insured upon their lives, who are embarrassed in their affairs, resort to self-destruction, being willing to end a wretched existence if they can thereby bestow comfort upon their families. The jury would be likely to repudiate such a theory on the ground that nothing can compensate a man for the loss of his life. The jury may be right and the company may be wrong, but the company has expressly provided that their judgment, and not the judgment of the juror, shall govern."

But suppose that the applicant does tell part of his insurance but omits some. In that case it would come under the head of partial or incomplete answers (see p. 504), and, if warranted, would be construed rigidly against the insured. This point is well brought out in the case of *Brennan* vs. *Ins. and Annuity Co.*, in which, on appeal to a higher court (4 Daly 296), it was held as follows: "The judge also erred in refusing to direct the jury to find a verdict for the defendants if they believed the insured withheld from the defendants the fact that he held two [undisclosed] policies in the Guardian and Equitable Companies, shown to have been for $30,000 in addition to the $35,000 [disclosed], but referred to his previous charge, in which he had stated that, as to the answer of the insured to the twenty-fifth question in the application ["What amounts are now assured on the life of the party, and in what company?" the answer being "Ætna, $10,000; Knickerbocker, $15,000; $10,000 additional applied for in Ætna"], 'if they found that George Schott, the assured, when he made that answer or declaration was guilty of a false or fraudulent representation, and that such representation was material in the judgment of the insurers, and induced them to take the risk, then you will find for the defendants.'

"In this there was a disregard of the contract of insurance sued on, in which it was expressly stated that 'if the declarations made by the

insured, and forming part of this contract, and upon the faith of which this policy is made, shall be found in any respect untrue, then and in such case the policy shall be null and void,' and without considering that entire truthfulness of such declaration was, by the contract, made matter of warranty, or condition precedent to any recovery upon it."

This question is construed thus closely by the courts because there is no decent excuse for any misstatement in reference to it. Ignorance cannot be pleaded, and any negligence in reference to it is culpable.

Prior Rejection.—This, like the preceding, is a question of so much moment to the company that it regularly asks in the application about the non-acceptance of the risk by any other company, or even if the risk has been accepted at a higher premium than was applied for. Unless directly asked by the company, it is not material for the applicant to make any statement concerning his prior rejection by another, as was decided in the case of *Goodwin* vs. *Life Insurance Co.*, 18 L. Can. Jour. 1.

But if the question is asked, absolute accuracy should be exercised in answering it, for the courts, regarding this as a matter of simple fact, have been quite strict in construing the answer. Thus, in the case of *McDonald* vs. *Life Insurance Co.*, 4 Bigelow's Life and Acc. Rep. 609, the insured denied falsely that there had been a prior rejection by another company. It was held that: "If the statement is not in every respect true in fact—not in the sense if it be fraudulent, or if it be a lie, or in the sense that there is moral culpability—then the policy is to be void." This rule was applied with great severity in *Edington et al.* vs. *Life Insurance Co.*, 77 N. Y. 564. In this case it was provided in the application, which was expressly made part of the policy, that if any of the statements were "in any respect false or fraudulent," the policy should be void. The insured was asked, "Has any application been made to this or to any other company for assurance on the life of the party? If so, with what result?" He answered, "Yes, and always successful. Yes, accepted." It was proven that the insured, one Diefendorf, filled up and signed an application to another company. He went with the agent, one Windsor, to the examiner's office, and, not finding him in, decided to return later. The agent in the meantime saw the examiner, who told him that the risk was a bad one, that the examination would be a farce and an unnecessary expense to the company. The agent then told these facts to the applicant, and destroyed the application. So that the applicant was never examined, and no record was received by the company. Nevertheless, the court held as follows: "This evidence shows beyond question that an application for insurance in the New Jersey Company had been made, and that it had not been successful. Windsor was agent of that company to receive such applications. When the application was delivered to him it was delivered to the company, and Diefendorf had done all he could do or was required to do to place himself in the attitude of an applicant for insurance. In forwarding the application to the office of the company, Windsor would act, not as his agent, but as agent for the company. The medical examination was no part of the application. That was something to be done after the application was made. It was an act to be done, not by Diefendorf, or at his expense, but by the medical examiner, as the agent of the company, and at its expense. The doctor knew him and was acquainted with his physical condition, and pronounced him unfit for insurance

without an examination. That left the case precisely as if an examination had been made and his application had been rejected. It was just such information as this that the questions put to the assured in these applications were designed to elicit. The answers were clearly untrue, no matter how innocently they may have been made. There was nothing upon this branch of the case for submission to the jury, and the judge should have held that these answers avoided the policies."

The case was brought up again before the same court (100 N. Y. 536), and the decision above given was affirmed in stronger language: "The test is not whether Windsor or the medical examiner had authority to finally reject the application. If they were utterly without authority to dispose of it, and so the company never acted upon it, at least there was an application to the company, which was not successful and did not end in an accepted insurance."

A rather fine point was made in the case of *Langdon* vs. *Life Insurance Co.*, 14 Fed. Rep. 272. Here the question was, "Has any application ever been made, either to this or to any other company, upon which a policy was not issued?" This was answered in the negative, but it was proven that on the day prior to his taking out the insurance with the above company he made application to another company, and was examined for it. The examiner considered the risk unsatisfactory, and so stated in his report to the company. This report was not acted on until several days later. In view of these facts it was held that: "If the question had been, 'Has any application ever been made, to this or to any other company, upon which a policy *has not been* issued?' I should have had little difficulty in deciding that the answer was false; but I think there is a distinction between the words '*was not*' and '*has not been*' issued. I think a person of ordinary intelligence might answer no to the first form of the question, supposing that the company desired to know whether an application had been made and rejected. But the application in this case had not been rejected. The examining surgeon had no authority beyond his certificate as to the physical condition of the party examined. Notwithstanding this certificate, the company might have issued a policy if it had chosen to do so. It did not, in fact, reject the application until some time after the application in this case had been made to the defendant. The question, as put, was somewhat ambiguous, and I think it contemplates, when fairly and reasonably construed, that the company desired to know whether an application had been made and rejected. So long as the matter was still pending, it does not seem to me that a negative answer to the question was an improper one."

Suicide.—In nearly all policies nowadays there is some proviso which tends to avoid the contract in case of the suicide of the policy-holder. Sometimes this restriction extends over the whole life of the policy, but more commonly it is limited to the first year or two. Upon the interpretation of these clauses has been expended a great deal of judicial learning and skill.

It is usually held that the expressions "suicide," "death by one's own hand," and "taking his own life," are synonymous. Thus, in the case of *Eastabrook* vs. *Life Insurance Co.*, 54 Me. 224, it is stated as follows: "The terms 'suicide' and 'dying by one's own hand' are generally used synonymously. Sometimes one form of expression is used and sometimes the other. They have the same meaning. 'Dying by one's own

hand' is but another form of expression for suicide." Again, in the case of *Cooper* vs. *Life Insurance Co.*, 102 Mass. 227, the Supreme Court of Massachusetts held: "Upon a careful consideration of the elaborate discussion of the matter in the cases above cited, by the dissenting judges as well as by those in the majority, we think that, as applied to this case, there is no substantial difference of signification between the phrases 'shall die by his own hand,' 'shall commit suicide,' and 'shall die by suicide.'"

The subject is so large and important that it must be very considerably subdivided; but the decisions have been so numerous, and to some extent conflicting, that it is difficult to reduce it to any systematic arrangement.

1. If a policy is taken out by one in good faith, and he subsequently commits suicide, there being no proviso against that act, it seems reasonable to suppose that the policy would not be avoided by such act, even though it was done voluntarily and while in full possession of his faculties. This is certainly the case if the suicide was committed while the insured was insane, and has been so decided in *Horn* vs. *Life Insurance Co.*, 2 Bigelow's Life & Acc. Cases 602.

Concerning the other phase of this question, dicta were laid down in *Hartmann* vs. *Life Insurance Co.*, 21 Pa. St. 466, as follows: "The court was very plainly right in charging that if no such condition had been inserted in the policy, a man who commits suicide is guilty of such a fraud upon the insurers of his life that his representatives cannot recover for that reason alone."

Against these dicta, which had no bearing on the ultimate decision in the case, are the rulings in the case of *Fitch* vs. *Life Insurance Co.*, 59 N. Y. 557. "The policy contained no stipulation that it should be void in case of the death of the insured by suicide. It was not taken out for the benefit of Fitch, but of his wife and children. Although they were bound by his representations and any fraud he may have committed while taking out the policy, the policy having been obtained through his agency, yet they were not bound by any acts or declarations done or made by him after the issue of the policy, unless such acts were in violation of some condition of the policy."

Similarly, in the case of *Mills* vs. *Rebstock*, 29 Minn. 381, it was held that "where the constitutions and laws of the association contain no provision qualifying the right of recovery in case of suicide, the heirs of a member are entitled to recover the amount stipulated, irrespective of the mode of his death."

A slight modification of this state of facts existed in the case of *Darrow* vs. *Fund Society*, 116 N. Y. 537. In the policy was a proviso against death in consequence of a violation of the law, but it was held "that suicide was no defense unless it came within some condition of the contract of insurance relieving the defendant from liability in such a case; that suicide was no crime in this State, although an attempt to commit suicide was."

Still another idea was presented in the case of *Aid Society* vs. *Wanner*, 24 Ill. App. 357. Here there was a proviso against death as the result of any immoral practice, but it was held "that an act of suicide was not an immoral practice within the meaning of the certificate covenanted against by the assured." These rulings are sufficient to show that at

present a policy would not be forfeited by suicide, if there were no provisions in it against that mode of death, unless some other circumstances influenced the decision.

2. If an insurance policy is taken out by one with intent to commit suicide, there being no proviso in the policy against that form of death, would it be avoided by that act?

Francis (*Annals and Anecdotes of Life Insurance*, p. 310) relates an anecdote of a case of this kind in his usual interesting style: "A man went and insured his life, securing the privilege of a free-dying Englishman, and then took the insurers to dine at a tavern to meet several other persons. After the dinner he said to the underwriters, 'Gentlemen, it is fit you should be acquainted with the company. These honest men are tradesmen, to whom I was in debt, without any means of paying but by your assistance, and now I am your humble servant.' He pulled out a pistol and shot himself."

Unfortunately, Francis deals so largely in romance that we cannot vouch for the accuracy of this story, especially since neither the name of the company nor of the insured is given.

In the case of *Smith* vs. *Benefit Society*, 51 Hun 575, a similar state of facts received judicial consideration. This case is so remarkable in many respects that it is worth while to go into details. In the first six or eight months of 1886, John Tyler procured insurance on his life to the amount of $282,000, divided among thirty-six different companies. In none of the policies was there any reference to suicide. He had a family dependent on his efforts to earn a living. These efforts had not proved successful. He was in considerable debt, and had no way by which to meet his obligations. In particular he owed Frederick H. Smith about $10,000, and to meet the obligation he took out a policy for that amount in the National Benefit Society of New York. He did not disguise the object for which he was seeking this insurance. He told friends that if he failed to raise money by other means within a reasonable time he would commit suicide, and in that way meet his obligations, and at the same time assure a future income to his family. He also made inquiries as to the easiest method of producing death. His financial affairs grew no better. The time approached when the second premiums on some of his policies would fall due. It became necessary for him to act. On November 9, 1886, he gave the proper directions for his burial and said that he assumed responsibility for his acts. On November 10th he wrote to his mother and told her that his policies were all in companies which made no condition as to cause of death; that in that way his plans were so laid that if he could not benefit or help himself he could help those whom he ought to help. On the next day he committed suicide. The company very properly resisted the payment of the policy, and proved the truth of the foregoing statements. The case was appealed to the General Term, and Judge Barnard gave the opinion of the court (51 Hun 576): "The policy was clearly a fraud upon the defendant without any condition that suicide avoided the policy. The deceased designed to get a large aggregate of insurance. He was unable, and did not intend, to continue the payment of the premium until death came naturally, but his purpose was to provide for creditors and family by causing his own death. This was a legal fraud in its inception, and a policy thus obtained never had any binding force in his hands. . . . The

jury were told that if the deceased took out the policy with the intent to commit suicide, and did, in fact, commit suicide in pursuance of that intent, the action failed if the deceased was sane when he took his own life, if he did so take it. This covers the whole case."

The case was finally carried to the Court of Appeals, and the judgment was affirmed (123 N. Y. 85). Judge Finch, in delivering the opinion, said: "Some of this evidence was resisted on the ground that death by suicide was no defense under the terms of the policy. That is true; but the defense was fraud, and suicide the ultimate agency by which the fraud was accomplished. It was necessary, therefore, to prove it, and in such a manner as to indicate that it was not an insane or sudden impulse, but the culmination and effective working out of a deliberately conceived purpose of fraud."

3. If there is a proviso in the policy against self-destruction, and the insured commits suicide voluntarily and intentionally, while in the possession of his faculties and conscious of the immoralities of the act, there is no difference of opinion. Under such circumstances the policy is avoided, and all authorities agree as to this. It makes no difference, of course, in these cases whether the policy was taken out in good faith or with intent to defraud the company by committing suicide.

4. On the other hand, even though there is a proviso against self-destruction, and the mode of death is by the insured's own hand, this does not avoid the policy if the act is purely accidental and unintentional. This has been held true in a case of poisoning by mistake, of accidental shooting, and in every case where the act of self-destruction was unintended by the party dying. This opinion is very well stated by Judge Rapallo in the case of *Penfold* vs. *Universal Life Ins. Co.*, 85 N. Y. 320, as follows: "The policy contained a condition that, if the person whose life was insured should 'die by his own hand or act, voluntary or otherwise,' the company should not be liable, etc.

"The sole defense to this action is the alleged violation of this condition, and the ground of appeal is that the court gave improper instructions to the jury in two respects:

"First, the defendant contends that the evidence shows conclusively that the deceased came to his death by taking an overdose of medicine which had been prescribed for him by his physician, and that the court therefore erred in leaving it to the jury as an open question to say whether or not the death arose from that cause; secondly, that the court again erred in instructing the jury that in order to sustain the defense they must find that the deceased took the overdose for the purpose of destroying his life, voluntarily, knowingly, and intentionally, it being conceded that there was no evidence of insanity. The exceptions to these two portions of the charge raise the only questions to be determined on this appeal.

"As to the first point there is not much difficulty. The evidence strongly tended to show that the deceased took an excessive quantity of the medicine, and that his death was attributable to that cause; but there was no direct evidence of either of these facts.

"The conclusions in respect to them depended upon inferences which it was within the province of the jury to draw. The serious question in the case is that which arises upon the charge that, in the conceded absence of any insanity, the defendant was not exempted from any liability

unless the deceased took the overdose for the purpose of destroying his own life, knowingly, voluntarily, and intentionally.

"The ordinary clause in life policies, that the insurer shall not be liable in case the person whose life is insured shall die by his own hand or act, has been repeatedly the subject of judicial construction, and it is now well settled that it is not to be construed as comprehending every possible case in which life is taken by the party's act, and that an unintentional or accidental taking of one's own life is not within the meaning of the clause. . . .

"The question in all cases of this character is the proper interpretation of a contract, and the point of inquiry is, what obligations the parties must, from the language used with relation to the subject-matter and the circumstances, be reasonably supposed to have intended to assume. The clause against suicide is clearly intended to protect the insurance company against the fraudulent act of the insured whereby he may, even at the sacrifice of his own life, secure a benefit to those whom he may desire to favor, at the expense of the insurance company. . . . At a later day in the history of life insurance, some companies, for the purpose of avoiding the difficulties involved in the inquiry as to the condition of the mind of the person committing self-destruction, stipulated for exemption from liability in all cases of suicide, whether 'sane or insane.' Others adopted the words 'voluntary or involuntary'; others, as in the present case, 'voluntary or otherwise.'

"It would not be a fair interpretation of this clause, in either of the forms mentioned, to hold it to cover the case of a purely accidental death from poisoning occurring to a sane person, through mistake or ignorance, though his own hand might have been the innocent instrument by which the deadly potion was conveyed to his lips. Such an accident cannot be presumed to have entered into the minds of the contracting parties, or to have been intended to be stipulated against. The insurance was intended to cover the risk of premature death, which might result from any of the casualties to which human life is subject—self-destruction being excepted. A purely accidental act, committed by a sane person with no idea of injuring himself, cannot be regarded as an act of self-destruction within the meaning of such a contract. Suicide is the act stipulated against. The words 'voluntary or otherwise' preclude the parties claiming under the policy, if the act was one of suicide, from setting up the condition of mind of the party committing it, and contending that it was an involuntary act of suicide. But still it must be a suicide, and who would contend that the taking of poison by mistake, or any other act which a sane person might innocently commit, though it should result in death, was what is ordinarily understood as self-destruction or suicide? It is unreasonable to suppose that one effecting an insurance upon his life, in stipulating against death by his own hand or act could intend to embrace such a casualty, or that the insurance company could fairly expect him so to understand."

A similar ruling was given in the case of *Life Insurance Co.* vs. *Hazelett*, 105 Ind. 212. Although the testimony as to the mode of death was a little dubious, it was held that: "Death resulting from accident or from an act which at the time it was entered upon or engaged in was not expected, or intended to produce that result, cannot be said to be within the meaning of the policy. . . . It is not averred that the assured

was insane. From causes over which he had no control a state of mental and physical weakness resulted, and while in that state he took an over-draught of whiskey, without any expectation or intention of destroying his life. Death was therefore the result of an accident, and the policy was not avoided."

In the case of *Edwards* vs. *Life Insurance Co.*, 20 Fed. Rep. 661, it was held that the accidental taking of poison (prussic acid) was not included under the clause "shall die by suicide, whether the act be voluntary or involuntary." The facts in the case were somewhat obscure, but the jury found that death was accidental.

5. If there is a simple proviso against self-destruction, and the insured commits suicide while insane, the determination of the effects of these circumstances has been different in different courts. The decisions seem to agree upon one point, that suicide is not in itself any evidence of insanity. Thus, in the case of *Coffey* vs. *Life Insurance Co.*, 4 Bigelow's Life and Acc. Rep. 224, it was held: "No presumption that insanity exists in the case supposed can be deduced from the mere fact that the death of the person was caused by his own physical act; for every legal presumption of a fact of that character must be founded and derived from some other fact or facts, with which it is usually or always found, as the result of general experience and knowledge, to be connected in a certain relation."

And this view was strongly approved in the later case of *Weed* vs. *Life Insurance Co.*, 70 N. Y. 561, in which this language was used: "It was also held in the same case, as it has been uniformly held in other cases, that as sanity is the normal condition of man, it is presumed as to each individual, and that it was incumbent upon the plaintiff to overcome this presumption by proof that the self-destruction was not the conscious, voluntary act of one responsible for his actions; that the insured was, in fact, insane. Insanity cannot be presumed from the mere fact of suicide, as was said by Judge Grover in the case cited, for the reason that experience has shown that self-destruction is often perpetrated by the sane."

6. Regarding the effect which the suicide of the policy-holder, while insane, has in avoiding the policy, there being a proviso against that mode of death, the decisions can be divided broadly into two classes, and will be so discussed:

(*a*) If an individual commits suicide voluntarily, and the act is carried out in an intelligent and purposeful manner in pursuance of a definite purpose, it is suicide on the part of the insured, even if he is urged thereto by an insane impulse, or if insanity exists to such an extent that the immorality of the act is not appreciated by him. This view is so ably set forth in the case of *Dean* vs. *American Life Ins. Co.*, 4 Allen (Mass.) 96, by the Supreme Court of Massachusetts, as to serve for a model of reasoning. It proceeds as follows:

"There can be no doubt that the facts agreed by the parties concerning the mode in which the insured destroyed his own life bring this case within the strict letter of the proviso in the policy, by which it was stipulated that it should be void and of no effect if the assured should 'die by his own hand.' The single question, therefore, which we have to determine is, whether, on the well-settled principles applicable to the construction of contracts, we can so interpret the language of the policy as to add to the proviso words of qualification and limitation, by which the

natural import of the terms used by the parties to express their meaning will be so modified and restricted that the case will be taken out of the proviso, and the policy will be held valid and binding on the defendants. In other words, the inquiry is whether the proviso can be so read that the policy was to be void in case the assured should die by his own hand, he being sane when the suicide was committed. If these or equivalent words cannot be added to the proviso, or if it cannot be held that they are necessarily implied, then it must follow that the language used is to have its legitimate and ordinary signification, by which it is clear that the policy is void.

"In considering this question we are relieved of one difficulty which has embarrassed the discussion of the same subject in other cases. If the proviso had excepted from the policy death by 'suicide,' it would have been open to the plaintiffs to contend that this word was to have a strict, technical definition, as meaning in a legal sense an act of criminal self-destruction, to which is necessarily attached the moral responsibility of taking one's life voluntarily, and in the full exercise of sound reason and discretion. But the language of the proviso is not necessarily limited by the mere force of its terms. The words used are of the most comprehensive character, and are sufficiently broad to include every act of self-destruction, however caused, without regard to the moral condition of the mind of the assured, or his legal responsibility for his acts.

"Applying, then, the first and leading rule by which the construction of contracts is regulated and governed, we are to inquire what is a reasonable interpretation of this clause according to the intent of the parties. It certainly is very difficult to maintain the proposition that, where parties reduce their contract to writing, and put their stipulations into clear and unambiguous language, they intended to agree to anything different from that which is plainly expressed by the terms used. It is, however, to be assumed that every part of a contract is to be construed with reference to the subject-matter to which it relates, and with such limitations and qualifications of general words and phrases as properly arise and grow out of the nature of the agreement in which they are found. Giving full force and effect to this rule of interpretation, we are unable to see that there is anything unreasonable or inconsistent with the general purpose which the parties had in view in making and accepting the policy, in a clause which excepts from the risk assumed thereby the death of the assured by his own hand, irrespective of the condition of his own mind, as affecting his moral and legal responsibility at the time the act of self-destruction was consummated. Every assurer, in assuming a risk, imposes certain restrictions and conditions upon his liability. Nothing is more common than the insertion, in policies of insurance, of exceptions by which certain kinds or classes of hazards are taken out of the general risk which the insurer is willing to incur. Especially is this true in regard to losses which may arise and grow out of an act of the party insured. Such exceptions are founded on the reasonable assumption that the hazard is increased when the insurance extends to the consequences which may flow from the acts of the person who is to receive a benefit to himself or confer one on others by the happening of a loss within the terms of the policy. Where a party procures a policy on his life, payable to his wife and children, he contemplates that, in the event of his

death, the sum insured will inure directly to their benefit. So far as a desire to provide in that contingency for the welfare and comfort of those dependent on him can operate on his mind, he is open to the temptation of a motive to accelerate a claim for a loss under the policy by an act of self-destruction. Against an increase of the risk arising from such a cause, it is one of the objects of the proviso in question to protect the insurers. Although the assured can derive no pecuniary advantage to himself by hastening his own death, he may have a motive to take his own life, and thus to create a claim under the policy, in order to confer a benefit on those who, in the event of his death, will be entitled to receive the sum insured on his life. Unless, then, we can say that such a motive cannot operate on a mind diseased, we cannot restrict the words of the proviso so as to except from the risk covered by the policy only the case of criminal suicide, where the assured was in a condition to be held legally and morally responsible for his acts. It certainly would be contrary to experience to affirm that an insane person cannot be influenced and governed in his actions by the ordinary motives which operate on the human mind. Doubtless there may be cases of delirium or raving madness where the body acts only from frenzy or blind impulse, as there are cases of idiocy or the decay of mental power, in which it acts only from the promptings of the lowest animal instincts. But in the great majority of cases where reason has lost its legitimate control, and the power of exercising a sound and healthy volition is lost, the mind still retains sufficient power to supply motives and exert a direct and essential control over the actions. In such cases, the effect of the disease is often to give undue prominence to surrounding circumstances and events, and by exaggerating their immediate effects on future consequences to furnish incitement to acts of violence and folly. A person may be insane, entirely incapable of distinguishing between right and wrong, and without any just sense of moral responsibility, and yet retain sufficient powers of mind and reason to act with premeditation, to understand and contemplate the nature and consequences of his own conduct, and to intend the results which his acts are calculated to produce. Insanity does not necessarily operate to deprive its subjects of their hopes and fears, or the other mental emotions which agitate and influence the minds of persons in the full possession of their faculties. . . .

"It is against risks of this nature—the destruction of life by the voluntary and intentional act of the party assured—that the exception in the proviso is intended to protect the insurers. The moral responsibility for the act does not affect the nature of the hazard. The object is to guard against loss arising from a particular mode of death. The *causa causans*, the motive or influence which guided or controlled the will of the party in committing the act, is immaterial, as affecting the risk which the insurers intended to except from the policy. This view is entirely consistent with the nature of the contract. It is the ordinary case of an exception of a risk which would otherwise fall within the general terms of the policy. These comprehended death by disease, either of the body or the brain, from whatever cause arising. The proviso exempts the insurers from liability when life is destroyed by the act of the party insured, although it may be distinctly traced as the result of a diseased mind. It may well be that insurers would be willing to assume the risk of the results flowing from all diseases of the body, producing death by the opera-

tion of physical causes, and yet deem it expedient to avoid the hazards of mental disorder, in its effects on the will of the assured. . . .

"It was urged by the learned counsel for the plaintiffs very strongly that this view of the construction of the contract was open to the fatal objection that it would necessarily lead to the absurd conclusion that death occasioned by inevitable accident or overpowering force, or in a fit of delirium or frenzy, if the proximate and immediate cause was the hand of the person insured, would be excepted from the risk assumed by the defendants. But this objection is sufficiently answered by the obvious suggestion that such an interpretation, although within the literal terms of the proviso, would be contrary to a reasonable intent, as derived from the subject-matter of the contract. . . . The question in such cases is not how far can the literal meaning of words be extended, but what is a reasonable limitation and qualification of them, having regard to the nature of the contract and the objects intended to be accomplished by it. Applying this principle to the present proviso, and assuming that the plaintiffs are right in their position that the words used are not to be interpreted literally, it would seem reasonable to hold that they were intended to except from the policy all cases of death caused by the voluntary act of the assured, when his deed of self-destruction was the result of intention, by a person knowing the nature and consequences of the act, although it may have been done under an insane delusion, which rendered the party morally and legally irresponsible, incapable of distinguishing between right and wrong, and which, by disturbing his reason and judgment, impelled him to its commission. If the suicide was an act of volition, however excited or impelled, it may in a just sense be said that he died by his own hand. But beyond this it would not be reasonable to extend the meaning of the proviso. If the death was caused by accident, by superior and overwhelming force, in the madness of delirium, or under any combination of circumstances from which it may be fairly inferred that the act of self-destruction was not the result of the will or intention of the party adapting means to the end, and contemplating the physical nature and effects of the act, then it may be justly held to be a loss not excepted within the meaning of the proviso. . . . Those familiar with the business of insurance, and with the result of actions on policies of insurance in courts of law, know how difficult it is to establish a case of exemption from liability under an exception in a policy where it depends on a question of fact to be decided by the verdict of a jury. If this is true in regard to ordinary claims under policies, it is obvious that the difficulty would be greatly enhanced in cases like the present, where it would be sufficient, in order to take a case out of the operation of the proviso, to prove that self-destruction was the result of insanity. It would not be hazardous to affirm that, in all cases where such an issue was to be determined by a jury between an insurance company and the representatives of the deceased, the act of suicide would be taken as proof of insanity. . . .

"The learned counsel for the plaintiffs have insisted with great force on an argument drawn from the context, to show that the proviso was intended to embrace only a case of criminal self-destruction by a reasonable and responsible being. But it seems to us that the maxim *noscitur a sociis*, on which they rely, does not aid the construction for which they contend. The material part of the clause is, that the policy shall be void

if the assured 'shall die by his own hand, or in consequence of a duel, or by the hands of justice, or in the known violation of any State, national, or provincial law.' Now the first and most obvious consideration suggested by other parts of this clause is, that in enumerating the causes of death which shall not be deemed to be within the risks covered by the policy, one of them is in terms made to depend on the existence of a criminal intention. It is a 'known violation of law' which is to avoid the policy. This tends very strongly to show that where an act producing death may be either innocent or criminal, if it is intended to except only such as involves a guilty intent, it is carefully so expressed in the proviso. The inference is very strong that if they designed to confine the exception in question to cases of criminal suicide, it would have been so provided in explicit terms. . . . It seems to us to be a *petitio principii* to assume that death in consequence of a duel necessarily implies an act for which the party would be criminally responsible. Why is not this part of the proviso open to the same argument as that which is urged in regard to the clause relating to self-destruction? A duel may be fought by a party acting under duress, or impelled thereto by an insane delusion, which might blind his moral perceptions and render him legally irresponsible. If so, then the same answer to a defense set up against a claim under the policy would be open, under this clause, as the one now urged in behalf of the plaintiffs; and the argument founded on the assumption that a forfeiture under this part of the proviso necessarily involves a criminal violation of the law falls to the ground. Therefore the inference that a guilty intention is communicated from this branch of the proviso to that relating to death by the act of the assured seems to us to be unfounded. The only remaining clause is that which provides for the case of death by the hands of justice. This undoubtedly implies that the person insured has been found guilty of a criminal act by a judicial tribunal, according to the established forms of law. But it is not correct to say that it involves the existence of a criminal intent, because it might be shown that the conviction of the assured was erroneous, and that he was in fact innocent of the crime for which he suffered the penalty of death. So far, therefore, as any argument can be justly drawn from the connection in which the words as to self-destruction stand in relation to other parts of the proviso, it leads to the conclusion that it was not solely death occasioned by acts of the assured involving criminal intent or a willful violation of the law by a person morally and legally responsible, which was intended to be excepted from the risks assumed by the insurers; but that, with the exception of death in a known violation of law, the proviso embraces all cases where life is taken in consequence of the causes specified, without regard to the question whether at the time the assured was amenable for his act, either in *foro conscientiæ*, or in the tribunals of justice. . . .

"To say that insanity exonerates a party from a forfeiture under such a proviso in a policy is to assume that this was the intention of the parties when the contract of insurance was entered into. But if such was not the intention, then it follows that the assured gave an intelligent assent to a contract by which he stipulated that if he took his own life voluntarily, knowing the consequences of his act, he would thereby work a forfeiture of his claim under the policy, although he may have acted under the influence of insanity in committing the suicidal act. So that,

after all, we are brought back to the inquiry, What was the intention of the parties to the contract? in order to ascertain the true construction of the proviso.

"The result to which we have come, after a careful and deliberate consideration of the question, during which we have felt most sensibly the very great difficulties and embarrassments which surround the subject, is that the plaintiffs are not entitled to recover. The facts agreed upon by the parties concerning the mode in which the plaintiffs' intestate took his own life, leave no room for doubt that self-destruction was intended by him, he having sufficient capacity at the time to understand the nature of the act which he was about to commit, and the consequences which would result from it. Such being the fact, it is wholly immaterial to the present case that he was impelled thereto by insanity, which impaired his sense of moral responsibility, and rendered him to a certain extent irresponsible for his actions."

This opinion has been quoted at great length, because it seems to us to be the only logical one that can be applied in these cases; and further, the position is stated with such clearness, and every objection is answered so ably, that it seems as if it were incontrovertible; but human tenderness and the fact that corporations have no soul have elsewhere materially modified it, as we shall see later. In 1848 the well-known English case of *Dormay* vs. *Borradaile*, 5 M. & G. 380, was decided. In that case the jury found that the assured "voluntarily threw himself into the water, knowing at the time that he should thereby destroy his life, and intending thereby to do so; but at the time of committing the act he was not capable of judging between right and wrong." On appeal it was held by three out of four judges that the policy was avoided. Erskine, J., said "that the question whether at the time he was capable of understanding the moral nature and quality of his purpose is not relevant to the inquiry further than as it might help to illustrate the extent of his capacity to understand the physical character of the act itself." This was substantially repeated in the case of *Clift* vs. *Schwabe*, 3 C. B. 437, and may be considered accepted now in England; as is indicated in the case of *Stormont* vs. *Waterloo Life and Casualty Ass. Co.*, 3 Bigelow's Life & Acc. Cases 196, where the court instructed the jury that "the question is, Did the assured know that he was throwing himself out of the window? If he did, no recovery could be had under the policy."

In the United States the same principle has been again followed in Massachusetts in the case of *Cooper* vs. *Massachusetts Mutual Life Ins. Co.*, 102 Mass. 227, where it was said: "In the present case there was no offer to prove madness of delirium, or that the act of self-destruction was not the result of the will and intention of the party, adapting the means to the end, and contemplating the physical nature and effects of the act. The insanity, therefore, was not such as to take the case out of the proviso."

In New York the first case decided was against this view. This is the famous case of *Breasted* vs. *Farmers' Loan and Trust Co.*, 4 Hill (N. Y.) 73 and 8 N. Y. 299, the history of which is related quite fully on page 577. Even in this case three out of eight judges held a dissenting opinion, which was very ably expressed by Judge Gardiner, who said: "It is by the finding established that the assured cast himself into the

river for the purpose of drowning himself. The act committed by him was therefore voluntary, and accompanied by so much intelligence as to enable the agent to contemplate a particular result, and adopt the means requisite to accomplish it. His object was self-destruction by drowning. For this purpose he cast himself into the river, and thereby effected it. If this was not 'dying by his own hand' within the spirit and intent of this clause of the policy, it is difficult to attach any legal significance to such language.

"If, under the same circumstances, the assured had destroyed the property or assaulted the person of a citizen, he would have been civilly responsible for all the damages sustained by the latter. Insanity, unless it suspended the power of volition, would be no justification; still less a want of moral perception to distinguish between right and wrong.

"I can perceive no reason why upon the same principle he should not be held responsible for a willful breach of contract resulting from self-destruction, where it was premeditated, and accomplished by means usual and appropriate to effect his design."

At a later date this view prevailed in the case of *Van Zandt* vs. *Life Insurance Co.*, 55 N. Y. 169. Here it was held that: "In the practical administration of justice in cases of this description, it seems to us a dangerous doctrine to hold that the attention of the jury should be directed principally to the degree of appreciation which the deceased had of the moral nature of his act, and that this question, most speculative and difficult of solution, should be made the test by which it should be determined whether he had knowingly and voluntarily violated the condition of his insurance. The real question is whether he did the act consciously and voluntarily, or whether from disease his mind had ceased to control his actions. Supposing a man to be in the possession of his will and of the ordinary mental faculties necessary for his self-preservation, but that his mind has become so morbidly diseased on the subject of suicide that he cannot appreciate its moral wrong, and in this condition of mind he takes his own life voluntarily and intentionally, perhaps with the very object of securing to his family the benefits of an insurance upon his life, it is difficult to say that this is not a death by his own hand within the meaning of the policy. It has been doubted whether public policy would permit an insurance covering the case of intentional suicide by the assured while sane. But however this may be, no rational doubt can be entertained that a condition exempting the insurers from liability in case of the death of the assured by his own hand, whether sane or insane, would be valid if mutually agreed upon between the insurer and the insured. When nothing is said in the policy with respect to insanity, the words 'die by his own hand,' in their literal sense, comprehend all cases of self-destruction. The exceptions which have been grafted upon these words by judicial decisions must rest upon the ground that the excepted cases could not have been within the meaning of the parties to the policy. The intent on the part of the insurer in inserting the condition is evident. The policy creates in the assured a pecuniary interest in his own death. To a man laboring under the pressure of poverty and the urgent wants of a dependent family, or of inability to discharge sacred pecuniary obligations or other similar causes, the policy offers a temptation to self-destruction. To protect the insurers against the increase of risk arising out of this temptation is the object for which the condition

in question is inserted. The condition ought, therefore, to be so construed as to exclude only those cases in which these motives could not have operated, such as accident or delirium."

The views stated above in this section are those held also by the best-known text-books on life insurance, Biddle, May, and Richards. May says that "to hold 'death by his own hand' identical with criminal suicide, and to require freedom from irresistible impulse, is clearly making a new contract very different from the plain sense and spirit of the words. It is a question if any impulse that causes action is resistible. The prospect of providing for wife and family may in some states of mind be an irresistible motive, yet it is the very one the company wishes to exclude." Holland, France, and Germany apparently have adopted the same construction of this question. (6 Ins. L. J. 719.)

(*b*) Unfortunately, the sanctity of such motives, as providing support for wife and children, and possibly other considerations, have, in another class of cases, influenced the judicial mind; consequently we find it held that, even if the act of suicide be voluntary, still, to bring it within the exception it must be accompanied by an understanding of its normal aspect, an ability to distinguish right from wrong, and also a freedom from the influence of an irresistible impulse.

This view was apparently first enunciated in 1818 by the Chief-Justice of Bengal, in the case of *Bayley* vs. *Alexander*, Biddle on Insurance, sec. 832. It therefore has whatever merit antiquity may lend to it. The next case was that of *Breasted* vs. *Farmers' Loan and Trust Co.*, 4 Hill (N. Y.) 73, the dissenting opinion in which we have already quoted. In the prevailing opinion it was held that: "Suicide involves the deliberate termination of one's existence while in the possession and enjoyment of his mental faculties. Self-slaughter by an insane man or a lunatic is not an act of suicide within the meaning of the law." This case was finally carried to the Court of Appeals, and it was there held (8 N. Y. 299) by five out of eight judges as follows: "The connection in which they are used in this policy indicates that the phrase 'death by his own hands' meant an act of criminal self-destruction. . . . The connection in which they stand in this policy favors this construction. The first four exceptions in the policy are of acts innocent in themselves, three of which become inoperative if the defendants give their consent and have it indorsed on the policy. Then follow the last four exceptions, viz., if he shall die by his own hand, or in consequence of a duel, or by the hands of justice, or in known violation of any law, etc. By the acknowledged rule of construction, *noscitur a sociis*, the first member of the sentence, if there be any doubt as to its meaning, should be controlled by the other members, which are entirely unequivocal, and should be construed to mean a felonious killing of himself. It is a note laid by Lord Bacon that *copulatio verborum indicat acceptionem in eodem sensu;* the coupling of words together shows that they are to be understood in the same sense. And when the meaning of any particular word is doubtful or obscure, or when the expression, taken singly, is inoperative, the intention of the parties using it may frequently be ascertained and carried into effect by looking at the adjoining words, or at expressions occurring in other parts of the same instrument, for *quæ non valeant singula juncta juvant.* Besides, the words in this case are those of the insurer, and if susceptible of two meanings, should be

taken strongly against him. It was not intended on the part of the defendant that the policy would be avoided by a mere accidental destruction of life by the party himself. It was urged that it would be if the act was done intentionally, although under circumstances which would exempt the party from all moral culpability. It was insisted that it must be taken to mean a death by his own act. It seems to me that this is a yielding of the whole question. An insane man, incapable of discerning between right and wrong, can form no intention. His acts are not the result of thought or reason, and no more the subject of punishment than those which are produced by accident. The acts of a madman, which are the offspring of the disease, subject him to no criminal responsibility. If the insured, while engaged in his trade as a house-joiner, had accidentally fallen through an opening in the chamber of a house he was constructing and lost his life, the argument concedes that the insurer would have been liable. The reason is that the mind did not concur with the act. How can this differ in principle from a death in a fit of insanity, when the party had no mind to concur in or oppose the act? . . .

"If the insured was compelled by duress to take his own life, it will hardly be contended that the insurers could avoid payment. In what consists the difference between the duress of man and duress of Heaven? Can a man be said to do an act prejudicial to the insured when he is compelled to do it by irresistible coercion? and can it make any difference whether this coercion came from the hand of man or the visitation of Providence?"

This rule, although afterward reversed in the same State in the case of *Van Zandt* vs. *Mutual Benefit Life Insurance Co.* (see p. 576), furnished a precedent that has been elsewhere eagerly followed. The question was brought before the Supreme Court of the United States in the case of *Mutual Life Insurance Co.* vs. *Terry*, 15 Wall. 580. The dicta in this case are: "The propositions embodied in the charge before us are in some respects different from each other, but in principle they are identical. They rest upon the same basis, the moral and intellectual capacity of the deceased. In each case the physical act of destruction was that of George Terry. In neither was it truly his act. In the one supposition he did it when his reasoning powers were overthrown, and he had not the power or capacity to exercise them upon the act he was about to do. It was in effect as if his intellect and reason were blotted out or had never existed. In the other, if he understood and appreciated the effect of his act, an uncontrollable impulse, caused by insanity, compelled its commission. He had not the power to refrain from its commission or to resist the impulse. Each of the principles put forth by the judge rests upon the same basis, that the act was not the voluntary, intelligent act of the deceased. . . .

"We hold the rule on the question before us to be this: If the assured, being in the possession of his ordinary reasoning faculties, from anger, pride, jealousy, or a desire to escape from the ills of life intentionally takes his own life, the proviso attaches, and there can be no recovery. If the death is caused by the voluntary act of the assured, he knowing and intending that his death shall be the result of his act, but when his reasoning faculties are so far impaired that he is not able to understand the moral character, the general nature, consequences, and effect of the

act he is about to commit, or when he is impelled thereto by an insane impulse, which he has not the power to resist, such death is not within the contemplation of the parties to the contract, and the insurer is liable."

It will be noticed that this is even more liberal than the preceding case, for it brings in the idea of an irresistible impulse as well as a lack of appreciation of the moral consequences of the act. To the average juryman in such a case the convincing proof of the irresistibility of an impulse would be the fact that it was not resisted. It seems to us hardly worth the while to separate these decisions of such marked leniency into separate classes. One or both of them has been adopted in the following cases: *Life Insurance Co.* vs. *Groom*, 86 Pa. St. 92; *Schultz* vs. *Insurance Co.*, 40 Ohio St. 217; *Hathaway* vs. *Insurance Co.*, 48 Vt. 335; *Life Insurance Co.* vs. *Broughton*, 109 U. S. 121; *Eastabrook* vs. *Life Insurance Co.*, 54 Me. 224; *Blackstone* vs. *Standard Co.*, 74 Mich. 593; *Life Assn.* vs. *Waller*, 57 Ga. 533; *Knickerbocker Insurance Co.* vs. *Peters*, 42 Md. 414; *Scheffer* vs. *National Co.*, 25 Minn. 534.

The situation in New York State is rather interesting. In the case of *Breasted* vs. *Farmers' Loan and Trust Co.*, 4 Hill (N. Y.) 73, the court, as we have seen, made a most liberal decision, but this was overruled in *Van Zandt* vs. *Life Insurance Co.*, 55 N. Y. 169. Although in this latter decision the idea that moral irresponsibility excused the act of suicide is distinctly rejected, the doctrine of irresistible impulse is faintly outlined. This grew into large proportions in the case of *Newton* vs. *Life Insurance Co.*, 76 N. Y. 426, and became the predominant thought in the ruling; thus: "Without referring to the evidence in detail, our conclusion is that although it might have required the jury to find that Ross was aware when he took the laudanum that it would terminate his life, yet it would also have justified a finding that he acted under the control of an insane impulse caused by disease and derangement of his intellect, which deprived him of the capacity of governing his own conduct in accordance with reason. An act committed under such circumstances cannot be regarded as voluntary or within the proviso of the policy."

This view was affirmed in the case of *Meacham* vs. *Benevolent Association*, 120 N. Y. 237, where it was held that: "Unless, therefore, such self-destruction was the result of accident, mistake, or insanity, or was involuntary because he was driven to it by an insane impulse, which disabled him from controlling his own actions, Hay committed suicide within the meaning of the policy and it became void." This was a question of fact for the jury to determine, which they did in the usual way.

At this time we must range New York with the liberals in this matter. It is not worth while, for practical purposes, to separate cases of "moral irresponsibility" from those of "irresistible impulse." The result is the same, for the question, being one of fact, is left to the jury, and they always find for the plaintiff in these cases.

7. In order to obviate the difficulties mentioned in the previous section, the companies have inserted additional qualifying words, commonly "sane or insane." The following expressions have been considered as synonymous with that: "self-destruction, felonious or otherwise," "while insane," "dying by his own act or intention, whether sane or insane." But the meaning must be very clearly expressed, or the courts will disregard the apparent intention of the insurers and rule against them, for, as has been already stated, it is well understood that, in case of any

doubt, the interpretation of the contract will be adverse to the insurers, as they were the ones who drew it up. Consequently, the following clauses have not been held to make any additional restriction: "dying by his own hand or act, voluntarily or otherwise" (*Jacobs* vs. *Life Insurance Co.*, 5 Bigelow's Life & Acc. Cases 42), "under any circumstances die by his own act or hand" (*Schultz* vs. *Insurance Co.*, 40 Ohio St. 217).

These additional qualifying words first quoted have been interpreted in two different ways:

(*a*) By some it is held that all acts of self-destruction not accidental were included in the proviso. In the case of *De Gorgoza* vs. *Life Insurance Co.*, 65 N. Y. 232, the restricting clause was "die by his own hand, sane or insane," and it was held as follows: "I shall assume that the jury found that when the hand of the assured delivered the fatal shot he was wholly bereft of reason. . . . If the words mean anything, it is just what they commonly import, and that is, if death ensues from any physical movement of the hand or body of the assured, proceeding from a partial or total eclipse of the mind, the insurer goes free. . . . We are of the opinion that, in the common judgment of mankind, it will be considered that when a totally insane man blows his brains out with a pistol he will be said to have died by his own hand within the meaning of a policy such as we have now under consideration." In this case the decision was rendered by three out of five judges. In the case of *Riley* vs. *Insurance Co.*, 25 Fed. Rep. 315, the restricting clause was "self-destruction, felonious or otherwise," and it was held that, no matter under what circumstances he killed himself, no recovery could be had under the policy, but of course that did not mean accidental death. In the case of *Scarth* vs. *Insurance Co.*, 75 Iowa 346, the clause was "suicide, felonious or otherwise, sane or insane." This was held to cover "all suicidal acts, whether such as are denominated criminal, or such as are the offspring of insanity," and a very similar view was held in the case of *Salentine* vs. *Insurance Co.*, 24 Fed. Rep. 159.

(*b*) In the other set of cases the additional restrictions are considered apparently to cover the case of intentional suicide, but not if the individual is unconscious of the physical nature of his act and its results, nor perhaps if he is acting under an irresistible impulse. Thus in *Pierce* vs. *Insurance Co.*, 34 Wis. 389, the restricting clause was "die by suicide, felonious or otherwise, sane or insane," and it was held: "The condition here relieves the company from liability only where the self-destruction was intentional, or committed by a party who was conscious of the nature of the act he was committing, or about to commit, and conscious of its direct and immediate consequences, though the act may have been unaccompanied by any criminal or felonious intent or purpose." Similar language, though not quite as explicit, was used in *Bigelow* vs. *Insurance Co.*, 93 U. S. 284, and *Streeter* vs. *Insurance Society*, 65 Mich. 199. In the case of *De Gorgoza* vs. *Insurance Co.* two judges dissented from the prevailing opinion and held views similar to the above.

8. In spite of all restricting words and provisos, there has been found a way to get around the exception in some cases, and that has been by the expedient of calling the suicide an accident. Generally speaking, that is a question of fact, and as such is presented to the jury for its consideration. And there hardly exists a jury which will hesitate in a choice between suicide and accident as the cause of death of one of their neigh-

bors. The good old principle, *de mortuis nil nisi bonum*, will allow but one conclusion.

Of course, if the facts are susceptible of two explanations, the natural, legal, and judicial presumption is that a case is one of accident rather than of suicide. Thus, in *Mallory* vs. *Insurance Co.*, 55 N. Y. 52, it was held that: "Death was caused by such an injury or the suicidal act of the deceased; but the presumption is against the latter. It is contrary to the general conduct of mankind; it shows gross moral turpitude in a sane person." Similarly, in the case of *Insurance Co.* vs. *Delpeuch*, 82 Pa. St. 225, it was held that: "The party alleging suicide must prove it. The mere fact of death in an unknown manner creates no legal presumption of suicide. Upon evenly balanced testimony the law assumes innocence rather than crime. Preponderating evidence is necessary to establish the latter."

The following cases show the present method of avoiding this issue. In the case of *Keels* vs. *Fund Association*, 29 Fed. Rep. 198, the insured had been suffering for some months from mental aberration due to softening of the brain. One afternoon his body was found in a pasture, near a fence from which he had apparently fallen, with a bullet-hole in his head and a pistol in his hand. The restricting proviso avoided the policy in case of "death by his own hand, sane or insane, voluntary or involuntary." The jury found for the plaintiff, on the ground that it was an accident. On appeal it was held: "Accidental or unintentional self-killing is not within a condition forfeiting a policy for suicide or taking one's own life, whether such death results from taking poison by mistake, supposing it a wholesome medicine, or from an act done in frenzy or delirium, as by leaping from a window, tearing off a bandage from an artery, or from an act done under the stress of an overpowering force. . . . If it were intended by this policy to include death by accident, it was easy enough to say so." Of course this ruling sounds and reads very nicely, and one might imagine from it that a cruel, grasping corporation was trying to defraud the beneficiary out of her rights on a mere technicality. But it appears that in the proofs of death which the beneficiary submitted to the company she declared, over her own signature, that her husband's death was due to suicide, superinduced by dementia. Also this was the verdict of the coroner's jury, which was presumably held within a short time after the death, and therefore while the circumstances were fresh and capable of accurate consideration. When one regards these facts there is but little justice in the decision, however correct it may have been legally.

In the case of *Phillips* vs. *Life Insurance Co.*, 21 Am. Rep. 549, it was held that if the defendant was insane when he committed the act of self-destruction, no responsibility could be attached to his act. But it was also held that there was a reasonable doubt as to the proof of his having committed suicide. The facts were, that he retired to bed, and about 1 o'clock A.M. a pistol shot was heard. The inmates of the house rushed in and found he was shot in the mouth and a pistol was lying on the floor near by. It was considered possible that an enemy might have shot him or that he might have done it accidentally. The burden of proof, of course, was on the insurers.

9. Our own view can be summed up in a few words. We do not think that the ordinary rules of criminal responsibility which are applied to the

insane should be considered adequate in these cases. The contract is a definite one, and it is never assumed that the individual, when he signed it, was anything but perfectly sane. What other contracts are avoided under similar circumstances? He assumed this contract knowingly and intelligently. It was understood by him that there was a proviso in it that the policy should be forfeited if he died by his own hand. It was reasonable for him and for any one else to suppose that this did not include death by accident under any circumstances. The only question left, then, is to construe what the term "accident" means. When an act is done involuntarily and unintentionally, or by an individual who is not able to form an idea of the physical sequence of cause and effect with reference to this particular act, such an act could well be included under the term "accident."

In the language of the Supreme Court of Massachusetts, "If the death be by accident, by superior and overwhelming force, in the madness of delirium, or under any combination of circumstances from which it may be fairly inferred that the act of self-destruction was not the result of the will or intention of the party adapting means to the ends, and contemplating the physical nature and effects of the act, then it may be justly held to be a loss not excepted within the meaning of the proviso."

But it is said that an insane delusion or an irresistible impulse may be so marked as to preponderate over the rest of the intellect, so that the subject is no longer responsible for his acts. That is true, but if it leave him with sufficient intelligence to adapt means to ends and to know the result of a contemplated act, such a grade of irresponsibility certainly should not abrogate this contract, made in good faith while he was perfectly sane, and set up in its stead another contract of very different import. If the delusion or impulse is so marked that he no longer understands the physical nature of the act, then it might be called an accident, and as such would not be included within the proviso.

ACCIDENT INSURANCE AND BENEFIT ASSOCIATIONS

BY

CORTLANDT F. BISHOP, PH.D.

In a treatise on medical jurisprudence it is necessary to consider but one branch of accident insurance, namely, that relating to the insurance of human beings against casualty. From this point of view accident insurance is really a branch of life insurance, and is therefore to a certain extent governed by the same rules. The ordinary life policy grants relief in case of death, however caused, or in the event of the assured's reaching a certain age. Accident insurance, on the other hand, provides against loss arising from death or disability caused by violent and external means rather than by disease, the latter being particularly the province of insurance by beneficial societies.

The first question that presents itself is one of definition. What is an accident? The Supreme Court of Pennsylvania has declared that it is "an event that takes place without one's foresight or expectation, an event which proceeds from an unknown cause, or is an unusual effect of a known cause and therefore not expected." (*North American Life and Accident Company* vs. *Burroughs*, 69 Pennsylvania State, 43.) It will be noted that the word is used in its popular sense, the element of the unforeseen being always present.

A contract of accident insurance is not one of indemnity, for a person cannot be indemnified for the loss of life or limb as he can for the loss of a house or ship. The allowance for disabling injuries, though usually so called, is not really an indemnity, for in most policies it is limited to a certain fixed sum per week, always less than the wages or income of the assured. In one of the few known cases of accident insurance in the form of an indemnity contract, the Court of the Exchequer held that the insurer was bound to indemnify the assured for the costs of medical attendance and expenses to which he was put by the accident, and not for loss of time or profits. (*Theobold* vs. *Railway Passenger's, etc., Company*, 10 Exchequer, 45.) The modern form of policy is more convenient in that it does away with the necessity of going into the assured's private affairs.

The applicant for accident insurance is seldom, if ever, required to submit to a medical examination. His application is based on a warranty of the truth of certain facts concerning his condition. Among these are physical and mental soundness, correct and temperate habits, and entire freedom from fits or disorders of the brain. It is frequently stipulated that any medical adviser of the insurer shall be permitted as often as

required to examine the person or body of the insured in respect to alleged injury or cause of death.

In addition to answering inquiries regarding other insurance, the applicant is obliged to state that he has no special journey or hazardous undertaking in contemplation. The companies are in the habit of dividing occupations into classes, each of which is insured at a given rate in proportion to the hazard. The policy is not avoided in case of a change of occupation, but the insured agrees that if injured while engaged in work classed as more hazardous, he shall be entitled to recover only such an amount as the premium paid by him would purchase at the rates fixed for such increased hazard. (*Standard Life and Accident Insurance Company* vs. *Martin*, 33 Northeastern, 105.) As in the case of life policies, the applicant may designate a beneficiary to take in case of death. Some accident companies will only insure persons between the ages of eighteen and seventy, and refuse to insure women of any age or men of sixty-five or more against anything but death. Other companies refuse to deal with cripples, deaf, dumb, or blind persons, or those who are reckless or without visible means of support.

Accident policies resemble marine policies in that they may be for a time or for a particular voyage. Voyage policies may or may not be limited in point of time, but are always made to cover a prescribed journey, and deviation is not permissible. In recent years, examples of accident insurance on a large scale have presented themselves. In consideration of a premium the insurer agrees to insure a railroad company, for example, against claims arising from personal injuries received by its passengers (*South Staffordshire Tramways* vs. *Sickness and Accident Association* (1891), 1 Queen's Bench, 402), or an employer against claims arising under the Employer's Liability Act. Such insurance is not regarded as opposed to public policy, and in England is sanctioned by statute. (44 and 45 Victoria, cap. xli.)

The word "accident" is so broad in its meaning that the companies have sought to limit its scope by inserting in their policies numerous exceptions, and it is the construction of general restrictive clauses that makes up the greater portion of the case law of the subject. So much depends upon the particular phraseology employed that it is a difficult matter to formulate any general rules. It may be said generally that the burden of bringing the accident within one of the exceptions rests on the insurer. (*Badenfield* vs. *Massachusetts Mutual Accident Association*, 154 Massachusetts, 77.) A policy covering accidents caused by "external" means was lately construed by the Court of Appeal in England. The assured stooped to pick up a marble, and in so doing dislocated the cartilage of his knee. He had never had any weakness in that limb, and the court held that the word "external" was used in contradistinction to an internal cause, such as disease, and that therefore the injured person could recover. (*Hamlyn* vs. *The Crown Accidental Insurance Company, Limited* (1893), 1 Queen's Bench, 750.)

In 1892 a curious case arose in London. The defendants offered one hundred pounds to any one who contracted influenza after taking a certain patent medicine. The plaintiff took the medicine according to directions, but, nevertheless, caught influenza. He sued for the reward, and one of the defenses set up was that it was a contract of accident insurance, and therefore unenforceable because not in the statutory form.

But the court overruled the objection. (*Carlill* vs. *Carbolic Smoke Ball Company* (1892), 2 Queen's Bench, 484.)

An accident policy does not usually cover death resulting from disease, and it therefore frequently becomes of importance to determine what was the cause of the loss complained of. A recent case on this point is *Bacon* vs. *United States Mutual Accident Association* (123 New York, 304). The assured died of malignant pustule, which the expert medical witnesses refused to characterize as a disease. They, however, admitted that it was a "pathological condition." The lower court ruled that the deceased came to his death by accident, but the Court of Appeals, by a divided vote, reversed the decision, and held that malignant pustule was a disease.

Sunstroke is not an accident, but a disease. (*Sinclair* vs. *Maritime Passenger's Assurance Company*, 3 Ellis & Ellis, 478; *Dozier* vs. *Fidelity and Casualty Company*, 46 Federal Reporter, 446.) Though a known consequence of undue exposure to the heat, it could not have been foreseen, and was undoubtedly caused by external means, which is the definition usually given in contracts of accident insurance. The English court, however, went upon the ground that a disease produced by known means could not be considered as accidental. The American case was decided partly on precedent, but largely on the authority of Niemeyer and Obernier, who classed sunstroke as a disease of the brain, and held that the rays of the sun were not essential to its occurrence.

If, however, the disease is the result of an accident, the insurer is held liable. So a death from peritonitis, due to a violent blow on the stomach (*North American Life and Accident Company* vs. *Burroughs*, 69 Pennsylvania State, 43), or from hernia brought on by an accidental fall (*Fitten* vs. *Accidental Death Insurance Company*, 17 Common Bench, New Series, 122; *Traveler's Insurance Company* vs. *Murray*, 16 Colorado, 296), is covered by an accident policy. The question is one of proximate cause, and is often of considerable nicety. Thus a death from erysipelas brought about from a wound by a cut was considered the result of the disease rather than of the wound. (*Smith* vs. *Accident Insurance Company*, Law Reports, 5 Exchequer, 302. See also *Young* vs. *Accident Insurance Company of North America*, 6 Law Reports, Superior Court, Montreal, 3.) Porter, in his work on Insurance (second edition, p. 457), cites two English cases on this subject which are difficult to reconcile. In the one, gangrene from a cut was held to be an accident; and in the other, death by dislodgment of a gall-stone, the result of a fall, was held not a death by accident. In a recent New York case, the insured died of blood-poisoning, following upon a wound in his right hand. Some time previously he had injured his other hand, and it was an open question whether or no the pus from the first wound had entered the second and caused the poisoning. The death being charged to the second wound, the court held that it was for the jury to determine whether or no death was due to the accident. (*Martin* vs. *Equitable Accident Association*, 61 Hun, 467.)

Several cases have arisen in which a fit coöperated to produce the death of the assured, and yet his representative was allowed to recover under a policy in which a fit was an excepted cause. In three instances the deceased fell into a pool of water and was drowned. (*Reynolds* vs. *Accident Insurance Company*, 22 Law Times, N. S., 820; *Winspear* vs. *Accident Insurance Company*, 6 Queen's Bench Division, 42; *Tennant* vs. *Traveler's*

Insurance Company, 31 Federal Reporter, 322.) In another case the insured was seized with a fit while standing on the platform of a railway station. He fell on the track as a train was approaching, and was killed. (*Lawrence* vs. *Accident Insurance Company*, 7 Queen's Bench Division, 216.) The ground for these decisions seems logical, for the deaths were not the necessary results of the fits, but were caused by an accident, i.e., the way in which the deceased fell. It has been intimated that the rupture of a blood-vessel while using Indian clubs is not an accident unless some unforeseen and involuntary movement of the body occurred. If the death were caused by inflammation of the lungs consequent upon such rupture, an accident policy would cover the loss. (*McCarthy* vs. *Traveler's Insurance Company*, 8 Bissell, 362.)

The insurer is generally not liable when a supervening disease aggravates the original injury and produces death. On the other hand, when the insured died from pneumonia, which he contracted while in a weakened condition from an injury to his shoulder, it was held that as disease and subsequent death could not have occurred but for the accident, the insurer was liable. (*Isitt* vs. *Railway Passenger's Assurance Company*, 22 Queen's Bench Division, 504.) This distinction, though apparently well founded, may be difficult in its practical application.

Death from drowning, even when in bathing, is an accident (*Knickerbocker Casualty Insurance Company* vs. *Jordan*, 11 Insurance Law Journal, 475), and so is death from asphyxiation, whether by natural (*Pickett* vs. *Pacific Mutual Life Insurance Company*, 144 Pennsylvania State, 79) or by illuminating gas. (*Paul* vs. *Traveler's Insurance Company*, 112 New York, 472. In this case the Court of Appeals made a distinction between breathing gas involuntarily and inhaling gas, the latter being excepted by a clause in the policy.) Death from a pistol-shot fired by another person is an accidental death, even if the shooting is intentional. (*Supreme Council, Order of Chosen Friends* vs. *Garrigus*, 104 Indiana, 133.) But as a matter of fact, accidents arising from intentional injuries, whether caused by the insured or by another person, are excepted in the policies of many companies. Other customary exceptions are injuries happening while under or through medical and surgical treatment (except amputations necessitated solely by injuries, and made within a certain period after the accident), and while under the influence of intoxicating liquors or narcotics.

In construing exceptions with regard to poison, the courts have been very strict, attributing to the word its popular conception. Accordingly, malignant pustule caused by contact with the flesh of a putrid animal was not poison within such a clause. (*Bacon* vs. *United States Mutual Accident Association*, 44 Hun, 599; 123 New York, 304.) But poison taken by mistake for medicine (*Cole* vs. *Accident Insurance Company*, 61 Law Times Reports, 227) is within the clause. An accidental overdose of opium, a proper dose having been prescribed, will prevent recovery under a clause excepting death caused wholly or in part by medical treatment. (*Bayless* vs. *Traveler's Insurance Company*, 14 Blatchford, 143.) On the other hand, in case the exception is to operate, if the insured "die by his own hand or act, voluntary or otherwise," it is held that death from an overdose of medicine will not avoid the policy, as the clause is evidently intended to cover suicidal self-destruction. (*Penfold* vs. *Universal Life Company*, 85 New York, 317.)

Some policies stipulate that the injury shall not be one of which there is no external or visible sign. The courts are not apt to favor such clauses, perhaps because they are an attempt to construe the laws of evidence. Accordingly, a late New York case decided that an injury to the diaphragm and contiguous muscles which was not visible to the eye, but could only be ascertained by applying the hand to the exterior of the body, was not within the proviso. (*Gale* vs. *Mutual Aid and Accident Association*, 66 Hun, 600 (1893).) When the deceased was found dead in bed with the gas turned on, the court held the company liable on a similar policy, though there was no visible or external sign on his body. The ground of the decision was that the clause applied only to an accident not causing death. (*Paul* vs. *Traveler's Insurance Company*, 112 New York, 472.) Soreness is not a visible sign, and in a case where the body was covered with red spots and there was bloody froth at the mouth, the question was left to the jury. (*United States Mutual Accident Association* vs. *Newman*, 84 Virginia, 52.)

Generally an accident policy will cover injuries resulting from the negligence of the assured. Nice questions often arise when the policy excepts such injuries. Thus, when the assured, after he had seen two men jump safely five feet from a platform to the ground, followed their example, and received a stricture of the duodenum resulting in death, it was held a question for the jury as to whether there was an accident. (*Association* vs. *Barry*, 131 United States, 100.) "Voluntary exposure to unnecessary danger" is a common clause; and "walking or being on a railroad track or bridge" are also often forbidden. But getting on a slowly moving train is not within the first clause (*Schneider* vs. *Provident Life Insurance Company*, 24 Wisconsin, 28), and it would seem that crossing a railroad track to reach a railroad station is not necessarily within the prohibition of that last mentioned. (*Duncan* vs. *Preferred Mutual Accident Association of New York*, 59 New York Superior Court Reports, 145.) Injuries resulting from a violation of law are also frequent exceptions. Thus, an accident from slipping upon frozen ground while returning from hunting on Sunday (*Duran* vs. *Standard Life and Accident Insurance Company*, 20 Insurance Law Journal, 1035, Vt.), or while engaged in a horse-race (*Insurance Company* vs. *Seaver*, 19 Wallace, 531), both acts being illegal by statute, discharged the insurers.

Some policies only cover accidents while traveling by public or private conveyance. It has been held that such a policy covers an accident caused by walking from a steamboat while en route to a train, even though the assured could have ridden in a hack. (*Northrup* vs. *Railway Passenger's Assurance Company*, 43 New York, 516.) Generally speaking, however, walking is not traveling in the manner indicated. (*Ripley* vs. *Insurance Company*, 16 Wallace, 336.)

The so-called indemnity is usually given in case the assured is "wholly disabled." Usually this would mean disability from performing one's usual vocation, and not a total disability for any kind of labor. (*Hooper* vs. *Accidental Death Insurance Company*, 5 Hurlstone & Norman, 546.) The loss of one's fingers or hand does not ordinarily constitute total disability. (*Hutchinson* vs. *The Supreme Tent of the Knights of the Maccabees of the World*, 68 Hun, 355.)

Throughout the United States and England there exist a vast number of beneficial societies engaged in the business of insurance against

death, accident, or sickness. These associations are really insurance companies on a coöperative plan without shareholders, the insured and insurer being members of the same organization, and each member being an insurer of all his associates. A loss on the part of one member is paid by means of an assessment upon the others, the purpose of such societies being benevolent, and not the earning of a profit. Generally speaking, insurance by these societies is governed by the same rules as the business of the regular stock companies, and in the absence of special provisions the courts hold that it is subject to the same statutory regulations. (See Biddle on Insurance, § 67.) A certificate of membership in such an association is virtually a policy, and the constitution and by-laws are always a part of the contract of insurance. The tendency of the courts is to limit benevolent societies strictly to the classes of beneficiaries designated in their charters, and any insurance for the benefit of persons not of those classes is void. (Biddle on Insurance, § 60.) Whenever a particular method of nominating and appointing beneficiaries has been adopted, it is held to exclude all others, and a person improperly designated cannot take the benefit of the insurance. (Biddle on Insurance, §§ 135, 137.)

Insurance by beneficial societies is now generally regulated by special statutes (for the English law, see the elaborate Friendly Societies Act, 38 and 39 Victoria, cap. lx.), and the recently adopted "Insurance Law" of the State of New York may be taken as an example of the most advanced thought upon this subject. "Fraternal Beneficiary Societies, Orders, or Associations" is the caption of the seventh article of "The Insurance Law." (Laws 1892, chapter 690; chapter 38, General Laws.) It is provided that nine or more persons may become a corporation for relief by insurance upon the mutual or assessment plan of members or beneficiaries in the case of sickness, disability, or death. A certificate must be filed with the superintendent of insurance, and accompanied by the sworn statement of at least three subscribers, to the effect that two hundred eligible persons have, *bona fide*, made written application for membership. These two hundred persons must subscribe an aggregate amount of $400,000, and pay in cash one full assessment amounting to at least one percent. of their subscriptions. Foreign corporations cannot do business in the State until they have filed similar papers. When these requirements have been complied with, a license is issued by the superintendent of insurance, and the association can begin business. (*Ibid.*, §§ 230–232 inclusive.)

With three exceptions, all beneficiary societies, whether voluntary or incorporated, doing any business authorized by this article, i.e., business not for profit or for gain, and the members of which are proposed, elected, and initiated in subordinate lodges, councils, or similar bodies according to prescribed rites and ceremonies, are declared to be mutual benefit fraternities, and exempt from the other insurance laws of the State. (*Ibid.*, §§ 233, 239.) Each society may adopt a constitution or by-laws, not inconsistent with the statutes of the State. (*Ibid.*, § 234.)

A benefit association may make such agreements as it pleases with its members for the payment of benefits, although a member is permitted to change his beneficiary at any time without the latter's consent. It is, however, forbidden to issue certificates for the payment of a greater sum of money than could be raised by one assessment upon all the members,

or for the payment of a gross sum upon the expiration of a fixed period of less than five years. The reason for every assessment, as well as the precise amount thereof to be used for the payment of other than beneficiary claims, must be truthfully stated in the notices. Benefit societies are permitted to distribute their revenues in accordance with their constitutions so long as no money collected for the payment of beneficiary claims is otherwise appropriated. All moneys or other benefits to be paid by these societies are exempt from execution or from seizure by process, either legal or equitable, for the purpose of paying a debt or liability of any member or beneficiary. (*Ibid.*, §§ 235, 236, 238.) All benefit associations are required to make detailed annual reports, and are, in fact, closely under the supervision of the superintendent of insurance. Their books and papers are at all times open to the inspection of State officers, and they are liable to a fine in case they neglect or fail to perform a duty imposed by law. The superintendent is also empowered to revoke the license of any society which conducts its business improperly, and the attorney-general is authorized to proceed at once against a delinquent association. (*Ibid.*, §§ 232, 237.)

THE OBLIGATION OF THE INSURED AND THE INSURER.

BY

R. C. McMURTRIE, Esq.

With regard to the relations of the medical profession to life insurance, they occur in the formation of the contract and in the inquiry into causes of death.

1. As the contract is based on the average duration of human life, the known conditions that tend to shorten it are essential in forming a judgment as to the probability of the particular life that is to be insured coming up to the average or falling short.

These facts cannot practically be obtained from any one but the applicant or person whose life is to be insured, i.e., on the termination of whose life a payment is to be made. The facts when thus ascertained are made the subject of examination by medical experts. Accuracy is essential, as it is in all cases where inferences are dependent on facts. But the limitation of accuracy is the capacity of the person examined to give the information. This the insurer takes on himself unless the contract interferes. The insured, on the other hand, takes on himself the burden of answering truthfully.

Obviously there are likely to occur cases where the answers are perfectly truthful and yet absolutely untrue. The insured assumes this peril where the contract stipulates for accuracy as a basis of contracting. The person inquired of may have forgotten absolutely or temporarily a most important fact, or he may have been misinformed on a matter which he never could know saving by information, but which all of us speak of as if we knew; e.g., our age and the ages of ancestors, even relationship and parentage, are mere matters of hearsay, and yet are always spoken of as known facts. So they are practically; but it is evident that if they prove to be untrue there has been a misrepresentation in an essential fact which is the agreed basis of the contract. But this depends on the contract.

There is, then, another and a distinct class of facts, which are subject, however, to the same rule. It frequently happens that a fact is not supposed to be material, and is therefore omitted.

On the other hand, it is plain that as the insurer is the questioner and proposes to act on the information received, he must so frame his questions that men must be able to comprehend what facts they include.

Now here there must come in the same rule that, strangely enough,

seems to have surprised the legal profession when enunciated in *Peek* vs. *Derry*, 14 Appeal, 337.

Even where there is a warranty of the truth of the answers, this rule must be applied where the answer is literally correct but is liable to the charge of being an evasion. The insurer is entitled to a truthful answer; but whether the question has been truthfully answered *must* depend on what was understood by the question. It is impossible that the insured can be held to warrant the truth of the answer if no person but a highly educated expert could have supposed it included an inquiry as to a particular fact. This question is one for the jury—the answer being literally accurate—Did the man believe what he said, or did he knowingly conceal or suppress with intent to deceive by evasion? It is not what somebody else thinks he *ought* to have known from the information he had. This would make the matter turn on a false issue, and substitute the comprehension of a judge or jury for that of the man who spoke, which is near to requiring a warranty of truth irrespective of the comprehension of the question. It is obviously the same thing as what occurred in *Peek* vs. *Derry*. The question was whether there was a fraudulent and deceitful representation. The court below held there was a liability if the representation was founded on information which ought not to have been believed, or was quite insufficient to warrant the statement, it being such as no prudent man would have acted on. The court subsequently disclaimed all intention to assert willful and conscious falsehood.

In the House of Lords it was ruled, and it is now the settled law of England—till it shall have been changed by act of Parliament—that while the frivolity of the evidence on which a man is said to have made a representation is a ground for refusing belief to his assertion that he did rely on it, still there can be no action for deceit unless there was intentional or conscious falsehood. It is difficult to resist the argument that a fraudulent deceit involves moral turpitude, and that to substitute another's judgment as to the sufficiency of the evidence to found belief omits the essential ingredient of the charge. Whether this will be accepted in this country or the old formula will be preferred, however inaccurate, is of course an open question. This line of reasoning emphatically applies to all cases of inquiries on which it is proposed to contract. If converted into warranties, as they are when recited in the contract or referred to as a basis of contracting, no doubt the fact asserted must be literally true; but whether the answers are also truthful answers must depend on the intention of the speaker. They may *seem* to be evasive—especially when the judgment is aided by competent counsel—but it is evident that must depend on the capacity of the speaker to comprehend the purport of the question, not on the capacity of a jury to see a meaning when aided by the trained dialectician.

No better illustration can be given than *Huckman* vs. *Fernie*, 3 M. and W. 505, 4 H. and H. 149, where the question was, "Who was the usual *medical attendant* of the life about to be insured?" That person had been attended for many years by a physician for a chronic disorder. Within a short time that physician had retired from practice and another was employed by the family, but who had seen the life insured only in reference to a matter of no moment. In reply the name of this gentleman was given. It is quite plain that to any one who comprehended the object

of the question this was absolutely false while literally true, and so it was held by the court in banc.

It may be, though, that all these distinctions are useless, because if there is a question for the jury it will always be answered in one way. There is no doubt about the fact that justice is very unfairly administered by juries if we mean justice according to law, and there can be no other standard in a court. But to a great extent the courts are themselves to blame for the miscarriage. If they would compel a categorical answer by the jury to the crucial question of fact, there would be much less probability of a false verdict. When juries are permitted to render a general verdict hypothetically based on their findings of certain facts, it is much more likely that what has been stated as a condition will be overlooked or disregarded; that when they are asked to say, "Did A believe that statement to be true, or did he intend to mislead?" it may be doubted whether this is not the only mode in which an ordinary jury can be used to advantage.

2. The medical profession is also intimately connected with the inquiry into the causes of death. They are necessarily experts in the proper inference to be drawn from facts ascertained after the event as to the condition of things before the death. Do these prove that the answers of the insured were false? Or wherever medical testimony as such can be pertinent to the issues raised in actions on policies, these necessarily include all things relating to the causes of death where they are relevant to the issues.

These statements seem to be supported by authority:

(1) If there is a warranty or a contract that a fact is true and it is made a condition, the materiality is unimportant. *A fortiori* is the intention to deceive.

Anderson vs. *Fitzgerald*, 4 H. L. Cases, 484; *Fowkes* vs. *Manchester*, 3 B. and Sm. 917; *Jones* vs. *Provincial*, 3 C. B. N. S. 65; *Wheeler* vs. *Hardesty*, 8 Ellis and Bl. 332; *McDonald* vs. *Law Union*, 9 L. R. Q. B. 328.

(2) But where there is a mere representation or where the contractual representation is so qualified as to be evidently a mere representation, as where "believed" is inserted, then materiality and intentional deceit are essential.

Huckman vs. *Fernie*, 3 M. and W. 505; and 1 H. and Hurles, 149. It appears to be implied in Parke's, B., remark in *Wainwright* vs. *Bland*, 1 M. and W. 35; *British Eq.* vs. *G. W. Ry.*, 38 L. J. Chan. 316; *Duckertt* vs. *Williams*, 4 Tyr. 242.

(3) That an evasion must have been known to be such where the statement is literally true. *Maynard* vs. *Rhode*, 1 C. and P. 360, where it is rested on the contract. *Geach* vs. *Ingall*, 14 M. and W. 93; *Perrans* vs. *The Marine and General Travelers' Insurance Co.*, 2 E. and E. 317; *British* vs. *G. W. Ry.*, 38 Law Jour. Chan. 132, 314; *General Prov. in re Damdriel*, 18 W. R. 396; *Fowkes* vs. *The Manchester*, 3 Fost. and Fin. 440; 3 B. and Sm. 916. It seems to be plain that if incorrectness is in itself sufficient to avoid the contract, it is misleading to call attention to the effect of the contract on making the truth of the statement a basis of the contract, and therefore essential, or, in the language of pleading, a material averment.

(4) Where there is an ambiguity the paper is to be read against the company who prepares it. *Anderson* vs. *Fitzgerald*, 4 H. L. Cas. 484–507.

OF CERTAIN LEGAL RELATIONS OF PHYSICIANS AND SURGEONS TO THEIR PATIENTS AND TO ONE ANOTHER.

By WILLIAM A. PURRINGTON, Esq.

Of Legislative Restrictions on Medical Practice.—To restrict needlessly the free use of his powers and talents is a wrong to the individual; it is also an injustice to the community. That every man should have as free scope to earn a livelihood or widen the field of knowledge as is consistent with the common welfare, is a truism. But it has been cleverly pronounced an easier task to renounce the devil and all his works than to know them when met with; so that while none will dispute the initial proposition, many controversies have arisen, and many will arise, over the need of restrictions. It is no new theory that an ignoramus should not be allowed to practice medicine. Socrates, wishing in his amiable way to ridicule Euthydemus, the handsome, likened that unfortunate youth to a supposititious quack who should seek appointment as a health officer upon the ground that, although ignorant of medicine, he could soon learn all about it by practicing upon the Athenians; at which illustration the gossips burst into laughter,* and, as a consequence, Euthydemus probably found something not entirely displeasing to him in the episode of the hemlock prescription. But the thoughts of all men do not widen with the process of the suns, and the advocates of ignorance as a qualification for medical practice have gone in late years far beyond this merry *reductio ad absurdum;* for with solemn faces they presented to the New York legislature of 1884 a memorial in favor of repealing the Medical Practice Acts, which declared that such powers as that of healing by "the laying on of hands" "cannot be imparted or increased by, but *are more likely to be diminished by, the course of study required by the medical colleges.*" Herein is the unconscious admission of one advantage of medical legislation: for while it would be manifestly undesirable, even if lawful, for a statute to ordain that any system of therapeutics should be followed exclusively,† since this would stifle experiment and progress, nevertheless it is reasonably certain that by requiring of all who begin to practice medicine a fair acquaintance with the human sys-

* *Memorabilia*, Bk. IV. c. 2, 3–5.

† Section 23 of the British Medical Act, 21 & 22 Vict. c. 90, provides that any body entitled to grant qualifications under the act shall forfeit its right if it persist in requiring as a condition of its examination or certificates, that the candidate shall "adopt or refrain from adopting the Practice of any particular Theory of Medicine or Surgery."

tem and the past and present condition of medical knowledge, the law protects the public in some degree against the imposture and ignorance of those who pretend, in good or bad faith, to substitute mysterious gifts for skill and learning.

The history of medical legislation is a story of reactions. An era of universal privilege to practise medicine, subject only to the risk of suits for malpractice, breeds a pest of quackery and an appeal for protection to the law-making power. A too rigorous enforcement of the letter of license laws begets counter-reaction. In the beginning of the eighteenth century the prosecution by the College of Physicians, of Apothecary Rose for prescribing a bolus to Seale, the butcher, although successful in the Court of Kings Bench,* failed in the House of Lords,† because it seemed intolerable to the peers that every one, their servants and the poor included, should be compelled in sickness to call in a physician to prescribe, an apothecary to dispense, and perhaps a surgeon to let blood. This victory made the apothecary a general practitioner in England, and such he is to-day. But a century of quackery drove the apothecaries themselves to procure an act‡ in the early part of this century forbidding any one to practise their art without the license of their company.§

The reaction against the fierce opposition to homeopathy, and a few other "pathies" in New York brought about a modification of the medical law of that State by the act of 1844, making an unlicensed physician a misdemeanant only in case of gross malpractice.‖ That act, in turn, has been repealed by subsequent legislation making all unlicensed practice a misdemeanor.¶ And if there is any lesson to be learned from studying the attempts to regulate medical practice, it is this: that whenever it is generally believed that such a regulation is only enforced either to benefit physicians, by limiting competition or regulating fees, or to suppress schismatic opinion, the law falls into disfavor and is repealed or becomes unenforceable.

Theory and Constitutionality of Medical License Laws.—Under the governmental theories obtaining throughout the United States, any statute obviously enacted to favor either physicians as a class in disregard of public right, or one class of physicians at the expense of others, would be unconstitutional.** Medical license laws are defensible solely on the ground that they are a fair exercise of the police power to protect the public health. It has been forcibly argued that their scope should be limited to punishing fraudulent pretenses of a nature to deceive persons of ordinary intelligence and care, such as the false assumption of medical titles; but should not be extended to forbidding the practice of unlicensed persons. Thus the purpose of the British Medical Act of 1858,†† as stated in its preamble, is "to enable persons requiring medical aid to

* 3 Salk. 17; 6 Mod. 44. † 5 Bro. Parl. Cases, 553.

‡ 55 Geo. III. c. 194. This act is not repealed by the Medical Act, c. 90, 21 & 22 Vict. Jones vs. [illegible], 53 L. T. 314; 29 Ch. D. 596.

§ For an account of this struggle between the physicians and apothecaries see "The Evolution of the Apothecary," *Medical Record*, Sept. 11, 1886, by the writer.

‖ See history of New York Medical Legislation prior to 1887 in the *Medical Record* of Oct. 23, 1886, by the writer.

¶ Laws of 1874, 1880, 1887, 1892, and 1893, the last statute being now in force.

** *State* vs. *Pennoyer*, 65 N. H. 113; 18 Atl. 878; *State* vs. *Hinman*, 65 N. H. 103; *State* vs. *Fleischer*, 41 Minn. 69.

†† 21 & 22 Vict. c. 90.

distinguish qualified from unqualified practitioners." Those who hold that this is as far as the law should go argue that fools can only be protected by incarceration, and that it is an ancient privilege to be cheated if you wish to be.*

The Apothecaries Act of 1815,† on the other hand, forbade unlicensed persons, under civil penalties for disobedience, to act as apothecaries; and this statute rather than the former has been followed and exceeded in our medical legislation, which, in nearly all the States, makes a criminal offense of unlicensed practice. The constitutionality of this prohibition has been directly passed upon and affirmed by the highest courts of most of these jurisdictions and by the Supreme Court of the United States; and by their decisions it is settled that such legislation is not a taking of property without due process of law,‡ that the fact of having been engaged in medical practice for years prior to the enactment of a licensing act does not create a vested right to continue in practice contrary to the new statute,§ and that the exemption of persons in practice prior to the date of the law from the examination, etc., required of persons thereafter beginning to practice does not create a "privileged class." ||

Among the various statutory provisions that have been held valid by the courts are the following: forbidding any one to practice medicine if neither graduated from the Harvard Medical School nor licensed by the Massachusetts Medical Society;¶ confining examinations by a State Board of Examiners to persons holding diplomas;** making residence in the State for a term of years a condition of the license;†† permitting all persons actually in practice at the date of the enactment to continue practicing upon registration and the payment of a fee of three dollars, but requiring of all commencing practice thereafter a diploma, registration, and a fee of ten dollars;‡‡ forbidding licensed physicians from opening shops for retailing, disbursing, or compounding medicines or poisons except in compliance with the pharmacy law;§§ exempting from the statute's operation all persons in practice within the State for ten years prior to its enactment;|||| permitting physicians of another State to visit the enacting State for consultation without the registration required of resident practitioners;¶¶ and creating a Board of Medical Examiners

* Analysis of Sir James Graham's Bill by John Davis, M.D., in his *Exposition of the Laws which Relate to the Medical Profession in England*, London, 1844; cf. *Smith* vs. *Lane*, 24 Hun, 632.

† 55 George III. c. 194.

‡ *Dent* vs. *State of W. Va.*, 129 U. S. 114; *State* vs. *Green*, 112 Ind. 462; 14 N. E. 352; *Williams* vs. *People*, 121 Ills. 84; 11 N. E. 881; *People* vs. *Phippin*, 70 Mich. 6; 37 N. W. 888; *Harding* vs. *People*, 10 Col. 387; 15 Pac. 727; *Hewitt* vs. *Charier*, (Mass.) 16 Pick, 353; *State* vs. *Board of Exrs.*, 32 Minn. 324; 34 Minn. 387; *ex parte* Spinney, 10 Nev. 323; *ex parte* Smith, 10 Wend. 449; *Logan* vs. *State*, 5 Tex. Ap. 306; *State* vs. *Pennoyer*, 65 N. H. 113; *State* vs. *Hinman*, 65 N. H. 103; 18 Atl. R. 194. The New Hampshire statute alone has been held unconstitutional.

§ *Dent* vs. *West Va., supra.; People* vs. *Fulda*, 52 Hun, 65.

|| *State* vs. *Green; Fox* vs. *Territory, supra.*

¶ *Hewitt* vs. *Charier*, 16 Pick, 353.

** *State* vs. *Vandersluis*, 42 Minn. 129; 43 N. W. 789.

†† *State* vs. *Green*, 112 Ind. 462; 14 N. E. 352; *State* vs. *Hathaway*, (Mo.) 21 S. W. 1081.

‡‡ *State* vs. *Creditor*, 24 Pac. 346 (Kansas).

§§ *People* vs. *Moorman*, 86 Mich. 433; 49 N. W. 263.

|||| *Williams* vs. *People*, 121 Ill. 84; 17 Ill. Ap. 274; 11 N. E. 881.

¶¶ *State* vs. *Van Doran*, 109 N. C. 864.

without providing for equality of representation upon it of the different medical "schools." *

Licenses and Examining Boards.—A diploma conferring the degree of doctor of medicine from an incorporated college is still a sufficient qualification to practice in most of the United States; † and if the statute requires a mere diploma, one of Buchanan's manufacture has been held to answer; ‡ but there is a growing tendency to require all candidates for license, including graduates of medical colleges, to pass the examinations of State boards. Even where diplomas are still accepted as licenses it is not unusual, owing to the number of worthless *soi-disant* medical schools, to require that they be issued by colleges, "reputable" or in "good standing," and it has been held that corporations formed under a general act to incorporate literary, scientific, and charitable institutions cannot confer the degree of "M.D." § Where the required license is the diploma of a "reputable college," examining boards have power to establish the criterion of what is "reputable" or "in good standing," ‖ and the exercise of their functions will not be reviewed by the courts, unless manifestly an abuse of discretion; such as the exercise of power either arbitrarily or for selfish motives. And under an Illinois decision, the function of the board cannot be delegated to a national association composed largely of men without the State. ¶ A board that has once recognized a school to be in good standing cannot thereafter arbitrarily refuse to certify the latter's graduates without a redetermination of the rating; ** but it may establish a standard of minimum requirements to which all schools "in good standing" must conform, ** and, if empowered to administer oaths and take testimony, may, after notice to the accused, act upon charges against a school, and if satisfied of its low standing, refuse to certify its graduates. ** In Colorado certificates of a *de facto* board, although illegally organized, will protect their holders. ††

A medical law may provide not only for the refusal of a license, ‡‡ but also for its revocation §§ for unprofessional conduct. ‖‖ But the candidate

* *Brown* vs. *People*, 11 Col. 109; 17 Pac. 104.

† It does not seem wise to consume space by setting forth the laws of the various States, or even making a synopsis of them. They are now in a transition state, and likely to be changed by every legislature. In New York, for example, the law of 1880 was altered in 1887, 1890, 1893, and is, as this book goes to press, likely to be revised again. The Illinois State Board of Health publishes from time to time an admirable report showing the medical legislation of different States and their existing medical colleges. But the only safe guide to the requirements of licentiates in any State is examination of its statutes in force.

‡ *Holmes* vs. *Halde*, 74 Me. 28.

§ *People* vs. *Gunn*, 96 N. Y. 317; *Townshend* vs. *Gray*, (Vt.) 19 Atl. 635.

‖ *Barmore* vs. *Board of Exrs.*, 21 Or. 301; *State* vs. *Bd. of Health Hudson Co.*, 22 Atl. 226.

¶ *Ill. St. Bd. of Dent. Ex.* vs. *People*, 123 Ill. 227; 13 N. E. 201. The same rule applies to granting diplomas by Medical Colleges: *People* vs. *N. Y. Homœopathic College and Hospital*, 20 N. Y. Supl. 379; *People* vs. *Bellevue Hospital Med. Col.*, 60 Hun, 107; 128 N. Y. 621; cf. *State* vs. *Gregory*, 83 Mo. 123.

** *Iowa Eclectic Med. Col. Ass'n* vs. *Schrader*, 55 N. W. 24.

†† *Brown* vs. *People*, 11 Col. 109; 17 Pac. 104.

‡‡ *State* vs. *Med. Ex. Bd.*, 32 Minn. 324; 20 N. W. 238.

§§ *State* vs. *Med. Ex. Bd.*, 34 Minn. 387; 26 N. W. 123; *ex parte* Smith, 10 Wend. 449.

‖‖ Under the British Medical Act the General Council of Education are sole judges whether a practitioner has been guilty of infamous conduct justifying the erasure of his name from the registry, and the courts will not interfere. *Ex parte* Lamert, 9 L. T. N. S. 410.

for license, or licentiate, must have notice and opportunity to answer the charges against him.*

In New Hampshire it was held that a license could not be refused solely on the ground that the applicant was unworthy of public confidence.† And under the California act, which provided a penalty only for practicing without having obtained a certificate, it was held that one who had obtained the requisite certificate might continue to practice notwithstanding its revocation.‡ A like result was arrived at in an Illinois case, wherein it was held that because the statute made the conferment of a diploma "conclusive" of the right to practice, therefore the board could not revoke the licenses of graduates, but only those of non-graduates.§ These and other grotesque modern instances go to show what a clumsy instrument legislation is when applied to restrain the customary actions of mankind; and when it attempts to regulate matters of taste and professional deportment the courts are not always ready to adopt the medical criterion of

Unprofessional Conduct.—Thus where the question arose in California whether a practitioner was guilty of such conduct in advertising himself as a specialist, one of the Supreme Court judges said, *obiter* to be sure: "As well might the board declare that wearing any other hat than one of white color, by a physician, should be unprofessional conduct, and cause it to be punished as a misdemeanor. The advertisement of the character mentioned does no harm to any one. It may be of benefit to the public by giving to the subject of the diseases mentioned information of the existence and residence of a person who has peculiar skill in curing them. Such laws are passed to prevent injury to the public, not to prevent or exclude a benefit to it." ‖ It appeared in the case of *The People* vs. *McCoy* ¶ that defendant's license had been revoked under the Illinois statute on the charge of "unprofessional and dishonorable conduct" in making statements, in reference to curing the sick, calculated to defraud the public. The *gravamen* of the offense was an advertisement under the caption, "A Surgical Triumph." The Appellate Court, although resting its decision on the point of lack of notice to defendant, said that the statute must have a reasonable, not a capricious, construction; and that "unprofessional" and "dishonorable" meant what would be so considered "in common judgment." So, in the case of a physician refused admission to a medical society because some years before he had advertised, the New York Court of Appeals affirmed the order of the Supreme Court granting a writ of mandamus commanding the society to admit the relator to membership on the ground that his advertising was *per se* "neither immoral nor illegal," the advertisement being decent in terms, while the provisions of the medical code of ethics had "the force neither of general law, nor of a rule of private morality," and were not binding upon any but members of the society.** But the court thought otherwise in the case of Dr. Hunter,** who advertised extensively

* *State* vs. *Med. Ex. Bd.*, 32 Minn. 324; *People* vs. *McCoy*, 125 Ill. 289; 30 Ill. Ap. 272; *State* vs. *Schultz*, 28 Pac. 643.

† *Gage* vs. *Censors*, 63 N. H. 92.

‡ *Ex parte* McNulty, 19 Pac. 237; 77 Cal. 164.

§ *Williams* vs. *People*, 17 Ill. Ap. 274.

‖ *Ex parte* McNulty, 77 Cal. 164.

¶ 125 Ill. 289; 30 Ill. Ap. 272.

** *People ex rel Bartlett* vs. *Med. Soc. of Erie*, 32 N. Y. 187. But it was admitted that advertising was ground for expulsion from medical societies that forbid it in

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24 Barb. 57

misdemeanors, or adjudged by the council guilty of "infamous conduct in a professional respect,"* and those who neglect for six months to answer letters of inquiry addressed to them by the registrars. Only registered practitioners can collect fees, claim exemption as medical men from jury duty, hold appointments in the military or naval service, on vessels merchant, or in certain public institutions, or sign the certificates required of medical men by the various statutes. The act also makes it a penal offense to assume any title falsely indicating that its bearer is registered, or entitled to be registered, under the law. Accordingly it was held unlawful that Thomas Andrews should append the letters "M.D." to his name, although he produced by way of defense a nicely engraved diploma purporting to confer upon him the degree of doctor from the University of Philadelphia, an eclectic concern now happily extinct, but at that time doing a brisk business in parchment. It did not appear that Thomas had ever been beyond the seas, and the court declined to recognize title by purchase in medical degrees; thus inflicting a severe blow upon the promising diploma industry.† However, another titulary of a different eclectic factory, now also only a memory, who in circulars of a not uncommon but somewhat offensive nature advertised himself as "John Hamilton, doctor of medicine of the Metropolitan Medical College of New York," fared better, since he only claimed a title that he possessed, and one upon its face not purporting to be a qualification under the act.‡ Violations of the British Medical Act are not indictable misdemeanors, but are punished by civil penalties. Where the registration system prevails in this country the unregistered practitioner is usually punished by fine, sometimes a penalty, generally of fifty dollars for the first offense. It is not customary to print the registers, but it is a general requirement that a physician, surgeon, or dentist must be registered in the offices of the clerk of each county wherein he practices or has an office.§ This has been held frequently in unreported cases to be the rule in New York, although there is a reported opinion of the General Term to the contrary, which seems, however, to have been based upon a loose construction of the law of 1880, which had been repealed by the statute of 1887 prior to the trial.‖ The present statute is explicit on this point. In Georgia a physician was said not to be responsible for non-registration due solely to the county clerk's neglect to provide a proper book for that purpose;¶ and in Texas one who had sent his certificate by messenger to be filed with the clerk was held not liable for practicing under the impression that it was recorded.**

* *Leeson* vs. *General Council of Med. Ed. & Reg.*, 61 L. T. 849; L. R. Ch. D. 366.

† *Andrews* vs. *Styrap*, 26 L. T. N. S. 704 Exch.

‡ *Carpenter* vs. *Hamilton*, 37 L. T. N. S. 157 Exch. Cf. *Reg.* vs. *Tefft*, 45 Upper Canada Q. B. 144, where one partner, being registered, had his name on the sign followed by the letters "M.D.; M.C. P. & S. Ont."; and the other, being non-registered, had his name followed only by the letters "M.D.," Held that the latter did not use a sign calculated to imply registration. In England a licentiate of the *Apothecaries Co.* cannot append M.D. to his name and hold himself out as a physician. *Reg.* vs. *Baker et al.*, 66 L. T. 416.

§ *Orr* vs. *Meek*, 111 Ind. 40; 11 N. E. 787; *Ege* vs. *Commonwealth*, 9 Atl. 471; *Hilliard* vs. *State*, 7 Tex. Ap. 69.

‖ *Martino* vs. *Kirk*, 8 N.Y. Supl. 758; 55 Hun, 474; cf. *Hayes* vs. *Webster Daily Reg.*, Jan. 26, 1884.

¶ *Parish* vs. *Foss*, 75 Ga. 439. Cf. *Carberry* vs. *People*, 39 Ill. Ap. 506 *infra*.

** *Pettit* vs. *State*, 28 Tex. Ap. 240; 14 S. W. 127.

Legal Disabilities of Irregular Practitioners.—In addition to direct punishment by fines and penalties, there are serious indirect consequences of illegal practice. Without the prescribed license and registration a physician cannot maintain an action to recover his fees;* although it has been held under the Wisconsin and Maine statutes that one who could not recover fees for lack of a diploma might, nevertheless, sue for damages on account of an injury preventing his practice;† but the statutes under which those cases were decided did not make the practice unlawful, but only affected a civil remedy. In the United Kingdom, as we have seen, those failing to comply with the law are specifically forbidden to hold medical appointments. Even in the absence of such prohibition, however, practically the result would be the same; for it is not likely that an open violator of the statute would be appointed to office, or even that his testimony as an expert would not be more or less discredited on cross-examination, if it should appear that he was practicing contrary to law. This phase of the registry system was illustrated in an assault case tried at Circuit, in Herkimer, N. Y., wherein an important issue was the possibility of deciding from the external appearances of the gum two years after the occurrence whether a tooth had been pushed in or pulled out. Each party called a dentist as an expert. The plaintiff's witness falsely qualified as a graduate of a dental college, while the defendant's admitted that he had received only office instruction. The plaintiff prevailed. An examination of the dental registry would have shown the perjury of the plaintiff's expert, and might have changed the result.‡ An unlicensed practitioner, moreover, is not entitled to such privileges as exemption from jury service: nor may he sign death-certificates. Communications between himself and his patients are not privileged.§ He may not maintain an action for slander if an amiable rival denounce him as a "quack." ‖ And in many indirect ways he may suffer. But a license will be presumed where that question arises collaterally, as where a physician is called as a witness; and the burden of proof in civil cases has been held to be on him who denies the license, although in prosecutions for violation of the medical laws the rule is otherwise.¶

What Constitutes Proof of Practice of Medicine.—Celsus truly says that the different branches of medicine are indissolubly bound together.** Nevertheless there has been always a separation of medical

* *Fox* vs. *Dixon*, 34 N. Y. St. R. 710; 12 N. Y. Supl. 267; *Haworth* vs. *Montgomery*, 91 Tenn. 16; 18 S. W. 399.

† *McNamara* vs. *Clintonville*, 62 Wis. 207; *Holmes* vs. *Halde*, 74 Me. 28.

‡ *Merville* vs. *Merville Herkimer Circuit*, Nov. 21, 1887 (unreported). Some statutes forbid the unlicensed medical practitioner to testify as an expert; *e.g.*, see Annotated Statutes, Wisconsin, § 1436.

§ *Wiel* vs. *Cowles*, 45 Hun, 307.

‖ *Hargan* vs. *Purdy*, 20 S. W. 432; *Skirving* vs. *Ross*, 31 Upper Can. C. P. 423; *Collins* vs. *Carnegie*, 1 A. & E. 695. *Aliter* if he charge him with killing patients by malpractice: *Marsh* vs. *Davison*, 9 Paige, 580; but it is not libelous to publish a true account of the action of the General Council of Education, etc., declaring plaintiff's conduct infamous: *Allbut* vs. *G. C. M. E. & R.*, 61 L. T. 585; 58 L. J. Q. B. 606; *cf.* *Fawcett* vs. *Charles*, 13 Wend. 473 *infra*.

¶ *City of Chicago* vs. *Wood*, 24 Ill. Ap. 40; *No. Chic. St. Ry. Co.* vs. *Cotton*, 29 N. E. 899; 140 Ill. 486; *People* vs. *Fulda*, 52 Hun, 65; and see below under the heading "Criminal Offenses."

** *"Illud ante omnia scire convenit quod omnes medicinæ partes inexæ sunt, ut ex toto separari non possint."*

men by specialization, both upon broad and somewhat distinct lines, into physicians, surgeons, dentists, and pharmacists, all of whom would mutually poach one on another's domain if there were a serious attempt to fix the boundary lines of each specialty, and also upon those narrower lines by which in these days each of our mortal parts bids fair to become the sole charge of a separate practitioner. Moreover, "schools," "pathies," and "systems" arise and fall, and will continue to do so while greed and credulity survive; which will be, probably, for some time to come. It is plain, therefore, that what constitutes the practice of medicine in any jurisdiction must be a question of fact as interpreted by the law of the place. Whatever "system" the practitioner may adopt, provided he be qualified under the law, the courts will recognize him as a physician, and will not favor one "school" at the expense of another.* If the statute undertakes to define practice, no acts will be punishable not falling within the definition; as where an element of the offense is receipt of fees or appending the letters "M.D." to the name.† But under a statute forbidding practice for reward it was held that actual receipt of money need not be proved where intent to take compensation could be presumed from the facts;‡ and the medicine prescribed need not be offered as evidence,§ for it would not seem to be a defense to a charge of illegal practice that the pretended drug was a bread pill; notwithstanding that it was said in a New York case that the purpose of medical legislation is "not to prevent persons being made the subjects of mere imposition," but "to confine the use of medicines and the operations of surgery to a class of persons who upon examination should be found competent and qualified to follow their professional pursuits"; wherefore it was held, in this case, that one who pretended to cure only by manipulation was not practicing medicine within the meaning of the act, "although if his pretensions were well founded then diseases would no longer be formidable, and even death itself would be deprived of its terrors."‖ In Maine it was held to be medical practice for a clairvoyant to prescribe remedies;¶ but under the peculiar statute of that State, allowing any one to receive compensation for medical service if he has a certificate of good moral character from the municipal officers of his town, a "Christian scientist" who had filed such a certificate prevailed in an action for fees.** The conviction of a "magnetic healer," who held himself out as a doctor and gave a death-certificate, was affirmed under the Michigan act;†† and in Indiana it was held that, whether or not the opium habit was a disease, Mr. Benham, not having complied with the medical laws, should be punished for issuing bill-heads and circulars fortified with certificates of his great skill in curing that evil practice, all bearing his name as "Dr. Benham."‡‡ To administer electricity§§ and to prescribe

* *Corsi* vs. *Maretzek*, 4 E. D. Smith, 1; *Patten* vs. *Wiggin*, 51 Me. 594; *Force* vs. *Gregory*, (Conn.) 27 Atl. 1116; *White* vs. *Carroll*, 42 N. Y. 161.

† *State* vs. *Carey*, 30 Pac. 729.

‡ *State* vs. *Hale*, 15 Mo. 606.

§ *U. S.* vs. *Williams*, 5 Cranch C. Ct. 62.

‖ *Smith* vs. *Lane*, 24 Hun, 632.

¶ *Bibber* vs. *Simpson*, 59 Me. 181. But in *Wood* vs. *O'Kelly* (8 Cush.), 62 Mass. 406, a mere clairvoyant was said not to be a physician.

** *Wheeler* vs. *Sawyer*, 15 Atl. 67.

†† *People* vs. *Phippin*, 70 Mich. 6; 37 N. W. 888.

‡‡ *Benham* vs. *State*, 116 Ind. 112; 18 N. W. 454.

§§ *Davidson* vs. *Bohlman*, 37 Mo. Ap. 576; cf. *Nelson* vs. *Harrington*, 72 Wis. 591. 40 N. W. 228.

under the guise of selling patent medicines or drugs* constitute medical practice. A single act of unauthorized medical attendance under circumstances showing intent to act as a physician is sufficient proof of practice, and under the North Carolina act, which prohibits an attempt to practice, it is sufficient to prove that defendant held himself out as a physician and solicited patients.† In the absence of any special medical law such holding out and practice are *prima facie* proof of the professional character of a party to a suit.‡ But a farrier who occasionally prescribes for human beings is not a practicing apothecary within the exemption clause of the British act.§ Under the general term "practice of medicine," acts of surgery are included, unless a contrary intent by both parties is clear.‖ Farmer Musser, who seems to have been well named, held himself out as a "cancer doctor," and pretended to special skill in treating cancers by a wonderful recipe. Mrs. Chase, who had a pimple on her nose, submitted to his treatment. He removed the pimple, and incidentally the nose. This was held to be practice of medicine.¶ But it was held not to be such a practice for one accustomed to gather herbs, and called doctor in his vicinity, to give remedies to and advise a sick friend as a neighborly act without fee.** Many medical laws expressly exempt from their operation certain classes of persons, as the medical staffs of the navy and incorporated hospitals and persons acting in "emergency"; but Lee Wah invoked this emergency-saving clause of the California statute in vain, when he claimed that, as his patient's case had been pronounced hopeless by all the Caucasian practitioners, an emergency existed wherein his eastern arts might be gratuitously practiced. The court, taking judicial cognizance perhaps of the fact that the cure of patients is not the sole reason for the existence of physicians, held that "emergency" under the act meant inability to get a qualified practitioner, not inability of the doctor to cure the patient.††

The Contract and Fees.—Under the Roman and civil law, and formerly in England, the services of a physician to his patient were in legal contemplation honorific, like those of an advocate or barrister.‡‡ Any

* *Alcott* vs. *Barber*, 1 Wend. 526; *Thompson* vs. *Staats*, 15 Wend. 395; *Smith* vs. *Tracey*, 2 Hall (N. Y.) 465; *Underwood* vs. *Scott*, 43 Kan. 714; 23 Pac. 942; *State* vs. *Van Doran*, 109 N. C. 864.

† *Antle* vs. *State*, 6 Tex. Ap. 202; *Ellison* vs. *State*, 6 Tex. Ap. 249; *State* vs. *Van Doran*, *supra*. In a recent English case, however (*Apothecaries Co.* vs. *Jones* (1893), 1 Q. B. 89; 5 R. 101), it was held that to advise, prescribe for, and dispense medicine to three separate persons on one day did not constitute three separate offenses. Hawkins, J., said: "The statutes contemplate habitual conduct, not isolated acts. . . . It is idle to lay down a golden rule upon the subject; each case must depend upon the particular circumstances attending it." And in a very late New York case an agreement not to practice within a certain radius was held to contemplate practice as a custom. *Greenfield* vs. *Gilman*, 140 N. Y. 168; cf. *Pedgrift* vs. *Chevallier*, 8 C. B. N. S. 240. In *Luck* vs. *Ripon*, 52 Wis. 196, the court declined to discuss whether acting as a midwife was practice of medicine.

‡ *Reynolds* vs. *Graves*, 3 Wis. 416; *Brown* vs. *Mims*, 2 Mill Con. (S. C.) 235; *Sutton* vs. *Facey*, 1 Mich. 243.

§ *Apoth. Co.* vs. *Warburton*, 3 Barn & Ad. 40; cf. *Steed* vs. *Henley*, 1 C. & P. 574.

‖ *Wetherell* vs. *Marion Co.*, 28 Iowa, 22; *Clinton Co.* vs. *Ramsey*, 20 Ill. Ap. 577; *Stewart* vs. *Raab*, (Minn.) 56 N. W. 256.

¶ *Musser's Executor* vs. *Chase*, 29 Ohio St. 577.

** *Nelson* vs. *State*, (Ala.) 12 So. 421.

†† *People* vs. *Lee Wah*, 71 Cal. 80; 11 Pac. 851.

‡‡ *Poucher* vs. *Norman*, 3 B. & C. 744.

one might give medical advice. The relation of physician and patient established of itself no right to compensation for services. And an action for fees could not be maintained by a physician on an implied contract, as might be done by apothecaries and surgeons,* who, being in England successors to the grocer and barber, were viewed rather as tradespeople. But if an express contract were made by the patient to pay for the services, an action would lie to enforce it.† Since the passage of the Medical Act, any one registered thereunder may bring an action to recover fees upon the implied contract unless the by-laws of his college forbid him to sue, in which event such prohibition may be pleaded in bar.‡ Such a by-law was made by the Royal College of Physicians, pursuant to the permission of the act, to wit: "No fellow of the college shall be entitled to sue for professional aid rendered by him;" but this prohibition applies only to fellows, not to members.§ In the United States the honorarium theory has never been favored; the relation of physician and patient has been regarded in law as merely contractual; and in the absence of special agreement an action will lie upon the implied contract,‖ which is on the physician's part that when he professionally attends a patient, at the latter's request or with his assent, whether for compensation or not is immaterial,¶ he undertakes not to insure or guarantee a cure,** but, first, that he possesses that reasonable degree of learning and skill which is ordinarily possessed by members of his profession and is regarded by the community and by those conversant with the employment, as necessary to qualify him to engage in medical practice; second, that he will use reasonable and ordinary care and diligence in the exercise of his skill and the application of his knowledge to accomplish the purpose for which he is employed; third, to use his best judgment in the exercise of his skill and the application of his diligence. Such is the rule laid down in a strenuously contested malpractice case in the State of New York,†† in which the decision followed along the lines of a leading New Hampshire case.‡‡ The same rule has been laid down in other jurisdictions with slight modifications; thus it has been said that the degree of skill and knowledge required in any locality must be that ordinarily possessed by physicians in the like general neighborhood and lines of practice,§§ having regard to the advanced state of the profession at the time; ‖‖ it being manifestly unfair to exact the same degree of attainment, especially in surgical skill, of a practi-

* *Dixon* vs. *Bell*, 1 Stark N. P. 287; *Chorley* vs. *Bolcott*, 4 T. R. 317.

† *Veitch* vs. *Russell*, 12 L. J. Q. B. 513.

‡ *Gibbon* vs. *Budd*, 32 L. J. Ex. 182; 21 & 22 Vict. c. 90, s. 31.

§ *Gibbon* vs. *Budd*, *supra* (note).

‖ *Peck* vs. *Hutchinson*, (Iowa) 55 N. W. 511; *Garrey* vs. *Stadler*, 67 Wis. 512; 30 N. W. 787.

¶ This seems to have been doubted, but it is the true modern and humane rule. *DuBois* vs. *Decker*, 130 N. Y. 325; *Becker* vs. *Janinski*, 15 N. Y. Supl. 675; 27 Ab. N. C. 45; *McCandless* vs. *McWha*, 22 Pa. St. 261; *McNevins* vs. *Lowe*, 40 Ill. 209; *Gladwell* vs. *Steggall*, 5 Bing., (N. C.) 733.

** *Hesse* vs. *Knippel*, 1 Mich. *nisiprius*, 109; *Becker* vs. *Janinski*, *supra*; *Teft* vs. *Wilcox*, 6 Kan. 46; *Lanphier* vs. *Phipos*, 8 C. & P. 475.

†† *Carpenter* vs. *Blake*, 10 Hun, 358; afd. 75 N. Y. 12 (see *Same Case*, 60 Barb. 488; rev'd 50 N.Y. 696); and cf. *Link* vs. *Sheldon*, 136 N.Y. 1; *Branner* vs. *Stormont*, 9 Kan. 51.

‡‡ *Leighton* vs. *Sargent*, 27 N. H., (7 Fost.) 460.

§§ *Small* vs. *Howard*, 128 Mass. 131; *Hitchcock* vs. *Burgett*, 38 Mich. 501.

‖‖ *Gates* vs. *Fleischer*, 67 Wis. 504; 30 N. W. 674; *Small* vs. *Howard*, 128 Mass. 131.

[illegible] in a sparsely settled country devoid of [illegible] may be properly expected of one practicing in [illegible] and misleading to charge th[illegible] bound to employ the degree of skill ordinaril[illegible] wherein he practiced, for it might happen t[illegible] [illegible] practicing in the vicinity,* and proper [illegible] have the average skill possessed by the profes[illegible] [illegible] to the advanced state of the profession at [illegible] ordinarily possessed by physicians.‡ So it h[illegible] standard by which to determine the skill to b[illegible] is not that of the thoroughly, moderately, or [illegible] average.§ The law recognizes both that a sm[illegible] is worth doing well and that in a grave cause [illegible] and therefore it has been held error to charg[illegible] and skill required of a surgeon should be pro[illegible] of the injury. And a refusal to call in other [illegible] considers himself competent to treat the case ne[illegible] [illegible] a physician's liability,¶ for the patient's [illegible] to dismiss the doctor, not to force him to cal[illegible] [illegible] is unnecessary. The physician's contract, [illegible] the standards of his "school," for the law recog[illegible] of practice as infallible.**

There is no legal obligation upon a physician [illegible] it is readily conceivable that such a refusal m[illegible] violation of the honorable standards and tradit[illegible] was formerly said that legally the obligation [illegible] nature of the mandate of the civil law, becaus[illegible] [illegible], and under the honorarium practice gratu[illegible] medical services were uncompensated that the [illegible] for gross negligence. But it is now consider[illegible] properly fulfilled; and a physician is bound, [illegible] even though gratuitously, to remain in charg[illegible] is needed, unless he be dismissed or sever his re[illegible] and the fact that the patient, a married wom[illegible] husband's house during the attendance does [illegible] relation.§§ It has been held, as a matter of ple[illegible] [illegible] of "carelessness, negligent, and unskillf[illegible] may be shown; [illegible] but the defendant may testi[illegible] case because a third person told him that he [illegible] he cannot repeat the conversation unless it too[illegible] [illegible]. Whether or not there was an abando[illegible] cases become a question for the jury, as in a re[illegible]

* [illegible] vs. [illegible], 56 Ind. 497.
† [illegible] vs. [illegible], [illegible] 55 N. W. 511.
‡ [illegible] vs. [illegible], Neb. 55 N. W. 252.
§ [illegible] vs. [illegible], 34 Iowa, 286; *Almond* vs. *Nug*[illegible]
‖ [illegible] vs. [illegible], 77 Ill. 162. ¶ *Potter* vs. [illegible]
** [illegible] vs. [illegible], 51 Me. 594; *Bowman* vs. *Woods*, [illegible]
†† [illegible] vs. [illegible], 15 N. Y. Supl. 675; cf. *Carpen*[illegible]
‡‡ [illegible] vs. [illegible], 64 Me. 305; *Dale* vs. *Donald*[illegible] 2 S. W. 713; [illegible] vs. [illegible], *supra*; and see note t[illegible]
§§ [illegible] vs. [illegible], 67 Barb. 578.
‖‖ [illegible] vs. [illegible], 37 W. Va. 159.

damages, resulting from a surgeon's alleged failure to discover a fracture of the arm. Defendant, who was in this corroborated by another surgeon, testified that the swollen condition of the arm when he was called in made it impossible at that time to discover the extent of the injury; that he gave proper instructions for reducing the swelling, and on his second visit was told not to call again. This the plaintiff denied, but the jury believed the doctor and gave him their verdict, which was sustained.* It follows from what has been said, and is also common sense, that a physician is the best judge of the number of visits necessary.† Whenever the question of lack of skill or qualification arises in malpractice, the burden of proof is on him who alleges it;‡ it being a corollary to the principle that a physician is not an insurer of success, that lack of skill will not be inferred from a bad result, but must be proved positively.§ Such being the physician's obligation, that of the patient is, first, to tell the physician frankly all about the case; second, to follow directions, if they be such as a physician of ordinary skill would sanction;‖ and failure in this regard will subject him to no other penalty than dying or getting well, whichever be the worse, according as the physician's skill, the patient's constitution, and Providence may determine; third, and not least important, to pay the doctor for his services,¶ an obligation which, should the patient die, survives to his personal representatives.

Apart from this implied contract, it is competent, of course, for doctor and patient, like any other persons, to make whatever special contract may please them. The Chinese plan of paying the medical man by the year, deducting all the time during which he suffers the patient to be ill, is not without merit, albeit founded on an estimate at once cynical and exalted of medical character and capability. This "no cure no pay" system is highly favored in rural communities where faith in panaceas flourishes. In Alabama, Dr. King contracted in this form to cure one Jones of his sickness by divers clysters. Prompt success not crowning King's efforts, Jones refused to submit further to the treatment unless informed what manner of stuff was injected into him. King refused to say more than that it was a good thing, though his own; but finding his honor, his nostrum, and above all his fee, in danger, he brought an action to recover of Jones one hundred dollars; whereupon Jones pleaded in defense that the panacea was no panacea at all, but a worthlessness. King got a verdict, but the Appellate Court reversed the judgment because Jones was not allowed on cross-examination to ask what the ingredients of the clyster were.** From such examples it would seem that the practical English custom of stationing an incorruptible boy

* *Gedney* vs. *Kingsley*, 62 Hun, 620; 16 N. Y. Supl. 792.

† *Todd* vs. *Myers*, 40 Cala. 355; *Ballou* vs. *Prescott*, 64 Me. 305.

‡ *State* vs. *Housekeeper*, 70 Md. 162; 16 Atl. 382.

§ *Pettigrew* vs. *Lewis*, 46 Kan. 78; 26 Pac. 458; *Sims* vs. *Parker*, 41 Ill. Ap. 284; *Lawson* vs. *Conaway*, 37 W. Va. 159.

‖ *Potter* vs. *Warner*, 91 Pa. St. 362; *Young* vs. *Mason*, 35 N. E. 521; cf. *Carpenter* vs. *Blake*, 75 N. Y. 12; and see article on malpractice on the point of how far failure to obey instructions is a defense to that action.

¶ *Peck* vs. *Hutchinson*, 55 N. W. 511; *Garrey* vs. *Stadler*, 67 Wis. 512; 30 N. W. 787.

** *Jonas* vs. *King*, 81 Ala. 285; 1 So. 591; cf. *Smith* vs. *Hyde*, 19 Vt. 54; *Mock* vs. *Kelly*, 3 Ala. 387. To the effect that a promise to cure savors of false pretense, see *Hupe* vs. *Phelps*, 2 Stark. 480.

in the hall to take fees in advance, or directing the patient to place the guinea stealthily somewhere in sight, preserves at once the dignity of the honorarium and secures the compensation of the physician even better than does the right to go to law. Another instance points the same moral, that it is wise to secure payment betimes. Nowadays, when wealth accumulates and rich men are unwilling to decay, it is not uncommon for Midas to carry Æsculapius with him *en voyage*, to their mutual pleasure and profit. Accordingly, when an amiable banker of New York, about sailing for Europe, asked his friend and family physician to accompany him, giving to the doctor also a check, a letter of credit, and tickets for himself and wife, it seemed to the medical man that he might safely relinquish his excellent practice for a while. Unfortunately, the patient was in good health, and very considerately declined to exact personal attendance of the doctor all the time, though expressing much pleasure in the latter's society and a desire to have him within telegraphic communication. The physician and patient, therefore, traveled separately, and while abroad met but three times, on none of which were medical services rendered. After the banker's death the physician sued the estate for the value of his services, and a referee nonsuited him. The General Term of the Supreme Court held, very reluctantly, owing to the physician's high character, that as there was no contract upon these facts, and no service had been rendered, there could be no valid claim against the executor.* But the Court of Appeals held the nonsuit to be erroneous, and on a new trial plaintiff secured a verdict. A somewhat similar case arose in Louisiana, whence a physician, practicing, however, as a dentist, was called to Atlanta by a dying aunt to look after her affairs. He rendered medical services to the invalid and charged the estate therefor; but the court refused to allow his bill, because he was not in attendance as a physician.† The question,

Who is liable for the fees? has often arisen. In a New York case, which has never been cited as authority, the court went so far as to hold that one who, in behalf of another, went for a physician and in the latter's absence left his card with the following message, "Call on Mrs. Day, at No. 769 Broadway," was liable for the doctor's services rendered to Mrs. Day; this on the ground that the messenger did not reveal his agency.‡ If this be good law, who can safely take a message to a physician? In a North Carolina case of like nature the jury reached a more sensible conclusion, and considered the defendant a mere messenger and not liable; there seems to be lacking in the former case that which is of the essence of all contract, a meeting of the minds of the parties on the same agreement and mutual consideration, actual or justly inferable. And the New York Court of Appeals, a few months after that decision, which was not appealed, reversed a similar but less unreasonable judgment of the General Term of the Supreme Court. It

* *Forbes* vs. *Chichester*, 8 N. Y. Supl. 747; revd. 125 N. Y. 769; retried as *Forbes* vs. *Kennedy*, 76 Hun, 39.

† Succession of Dickey, 60 So. 798; 41 La. An. 1010.

‡ *Bradley* vs. *Dodge*, 45 How. Pr. 57. But the same court held that one who left with a physician a telegram from his sick brother was not liable to the doctor for services rendered pursuant to the message; *Buck* vs. *Amidon*, 41 How. Pr. 370. So where a plantation physician sent for a surgeon to operate on a slave he was held not liable; *Guerard* vs. *Jenkins*, 1 Strobh. (S. C.) 171.

appeared in this latter case that Mrs. Martine, thirty years of age, whose husband was alive, lay ill at the house of her father, Mr. Bandouine, who employed two physicians to attend her. Like many another man, Mr. Bandouine grew anxious and told a neighbor, Mrs. Louther, that he wasn't satisfied, and wished that her doctor might see his daughter. Mrs. Louther said her physician was Dr. Crane. Mr. Bandouine spoke in like fashion to Mr. Louther, who said that Dr. Crane was "a first-rate physician"; whereupon Bandouine said he had an idea of sending for him. Subsequently a man, who afterward proved to be Mr. Martine, called on Dr. Crane and said that Mr. Bandouine would like that physician to call on his said daughter. Dr. Crane did call, and on many days, always finding in the room Mr. Bandouine, who received the doctor's instructions and acquiesced in his suggestion that yet another physician be called in. This was Dr. Crane's story, which Mr. Bandouine contradicted in material regards; but while the Appellate Court rested their decision on the ground that, in the conflict of testimony, the referee was entitled to believe the defendant and find accordingly, they also intimated strongly that the facts as recited by the doctor, even if uncontradicted, did not give rise to any implied contract by Mr. Bandouine to pay for medical services rendered to his adult married daughter.* To the same purport is a Pennsylvania case, where it was held that a father who called a physician to attend his adult son in the father's house was not liable.† And it was held in Alabama that an obligation to pay for medical services would not be implied necessarily on the part of a third person, who urged a physician to continue attendance which the latter had begun at the patient's request and was about to renounce.‡ So also where a man took his insane brother to a private lunatic asylum for care and treatment, the court said: "He is not liable unless he promised to pay."§ But wherever it is clear that the third person has induced the physician to render services upon his credit, then, undoubtedly, he is liable.‖ Thus in California it was held that one who called in a physician to attend his wife was estopped, notwithstanding the incompleteness of divorce proceedings instituted by the lady against her former lord, to deny the marital relation and assert one as tender but perhaps less legal. The case was curious, too, in this, that Dr. Gerlach, the physician, first sued the administrator of the lady, and was defeated by proof that she was married to Mr. Turner, who had employed the doctor; wherefore her separate estate was held not to be liable. With a laudable desire to collect his fees the physician then sued Mr. Turner himself, and again was nonsuited on the ground that decedent was but a fair friend of defendant, and had contracted to pay for the medical services out of her own estate. But the Appellate Court said that, while such a sphinx-like result, though a great hardship, might be legally possible, yet in this particular case the facts showed that Mr. Turner had represented himself

* *Crane* vs. *Bandouine*, 55 N. Y. 256; revg. 65 Barb. 260. Where A and wife gave a bond to support C, and a physician who attended C with Mrs. A's knowledge, but with notice that A would not be responsible, elected to credit C's estate; held that A and wife were not liable for his services. *Shaw* vs. *Graves* 8 Atl. 884; 79 Me. 166.

† *Boyd* vs. *Sappington*, 4 Watts, 247.

‡ *Currey* vs. *Shelby*, 90 Ala. 277.

§ *Smith* vs. *Watson*, 14 Vt. 332.

‖ *Hanford* vs. *Higgins*, 1 Bosw. 441.

as the lady's husband, which was quite enough to make him liable. So Dr. Gerlach got his fee by the aid, although almost in spite of the law;* for under the general principle that a husband must furnish his wife with necessaries suitable to her condition in life, he is liable for medical services rendered to her unless a special agreement on her part is shown,† even if without fault on her part she be living away from his domicile.‡ But she may contract to pay out of her separate estate; and if she be separated from her husband by her own fault, as if she be living in adultery, the latter will not be liable unless he authorizes the services.§ "Mesmeric treatment," including "dreams, visions, and revelations," has been held to be a "fancy article" and not necessary.‖

A father should supply his child with necessaries. In England and in some of our States this duty is imposed by law as to children of very tender years; and under an English statute to this effect, one of the "Peculiar People" was convicted of manslaughter because his child died for lack of medical attendance, which was not supplied, in obedience to the tenets of his sect, which held such aid to be contrary to the teachings of St. James V. 14, 15.¶ In a similar case in New York the child of an Episcopal missionary was taken from the father by a humane society and put under surgical care, because the parent, with greater faith than wisdom, refused to do more for the infant's broken arm than adopt this same apostolic but surgically ineffectual treatment; the bishop of the diocese, it is said, very properly disapproved of the missionary's views. Although at common law it is considered that the duty of employing a physician for a child is moral only and not legal,** still if the medical services can be said to have been rendered with the father's assent or with his knowledge and without objection, a contract will be implied; and such assent may be implied even though the child have left the parental roof;†† but not if the parent provide for the child and does not assent to the services.‡‡ Inability of the father to pay does not make the child liable.§§

Lord Kenyon was of opinion that a master was liable for medical services rendered to his servant;‖‖ but such is not the rule,¶¶ except where a contract of service involves that obligation, as apprenticeship.***

* *Gerlach* vs. *Turner*, 89 Cala. 446; 26 Pac. 870.

† *In re* Shipman's estate, 5 N. Y. Supl. 559; 22 Ab. N. C. 289. Revd. in part on another point: 53 Hun, 511; 23 Ab. N. C. 101; 6 Supl. 276.

‡ *Harrison* vs. *Grady*, 13 L. T. N. S. 369; *Thorpe* vs. *Shapleigh*, 67 Me. 235; *Webber* vs. *Spannhake*, 2 Redf. 258.

§ *Cooper* vs. *Lloyd*, 6 C. B. N. S. 519. As to separate estate, see *Moody* vs. *Osgood*, 50 Barb. 628.

‖ *Wood* vs. *O'Kelly*, 62 Mass. (8 Cush.) 406.

¶ *R.* vs. *Downs*, 13 Cox. C. C. 111, under 31 & 32 Vict. c. 122, s. 37. Prior to the statute there had been an acquittal in a like case: *R.* vs. *Wagstaffe*, 10 Cox. C. C. 530.

** *R.* vs. *Wagstaffe, supra; Kelly* vs. *Davis*, 49 N. H. 187; *Gordon* vs. *Potter*, 17 Vt. 348.

†† *Porter* vs. *Powell*, 44 N. W. 295; 79 Iowa, 151; *Gilley* vs. *Gilley*, 9 Atl. 623 (Me.); *Deane* vs. *Annis*, 14 Me. 236; *Swain* vs. *Tyler*, 26 Vt. 1; *Neilson* vs. *Gray*, 17 N. Y. Supl. 500; *Hunt* vs. *Thompson*, 4 Ill. 179.

‡‡ *Rogers* vs. *Turner*, 59 Mo. 116.

§§ *Hoyt* vs. *Casey*, 114 Mass. 397. An infant living with a parent or guardian who provides for it, cannot bind its estate for necessaries; but a stepfather is not bound to support his predecessor's children: *Atchison* vs. *Bruff*, 50 Barb. 381; cf. 3 Barn. & C. 484.

‖‖ *Scarman* vs. *Castell*, 1 Esp. 270. ¶¶ *Sellen* vs. *Norman*, 4 C. & P. 80.

*** *R.* vs. *Smith*, 8 C. & P. 153.

Agents.—Neither for services rendered to themselves or others can servants, not authorized to do so, bind principals to pay. Thus, if the superintendent of a corporation send for a physician to attend a man injured in its employ, no contract by the corporation to pay for the medical service can be implied from this fact alone; for the relation of employer and employed is not such as of itself to create the obligation.* But it is otherwise if the superintendent have authority to employ a doctor in such cases, and does, in fact, employ one.† Dr. Cooper sued the New York Central and Hudson River Railroad Company to recover fees for attending on and amputating the leg of one Haley, an employee of the defendant. It appeared that the engineer of defendant's train, Scanlon, had thus telegraphed to its station-agent, Martin: "June 6, J. Martin: Have Mr. Cooper at depot on arrival of No. 1; man hurt. J. Scanlon." Martin sent this telegram by a hackman to the physician, who also offered testimony, which was held irrelevant, to prove previous employment by defendant in other cases. The doctor was nonsuited upon the ground that there was no proof that the engineer and station-agent had power to bind the company to pay for medical services.‡ Where, however, a railroad conductor employed a physician under somewhat similar circumstances, and notice of the employment was conveyed by both conductor and physician to the company's superintendent and general agent, and the employment was not questioned or repudiated, the contract was held to be ratified, and a cause of action to recover fees made out.§ In England, since the cases cited in *Cooper* vs. *Railroad*, the employees' authority has been implied.‖ Where ratification is needed slight acts will be so construed.¶

If physicians are called in consultation with the assent of the patient, obviously he is liable to them for their fees; and in an extreme case the patient was held thus liable to a consultant called in by the

* *Meisenbach* vs. *Southern Cooperage Co.*, 45 Mo. Ap. 232.

† *McCarthy* vs. *R. R.*, 15 Mo. Ap. 385.

‡ *Cooper* vs. *N. Y. C. & H. R. R.*, 6 Hun, 276; citing *Stephenson* vs. *N. Y. & H. R. R.*, 2 Duer. 341; *Cox.* vs. *Midland Counties Railway*, 3 Exch. (Welsby H. & G.) 268.

§ *Terre Haute &c. R. R. Co.* vs. *Stockwell*, 118 Ind. 98; 20 N. E. 650; Mitchell, J., dissenting so far as the opinion seems to hold that the conductor could employ a physician without express authority to do so.

‖ *Walker* vs. *Great Western Ry. Co.*, 2 L. R. Ex. 228.

¶ *Cairo &c. R. R. Co.* vs. *Mahoney*, 82 Ill. 73. The modern tendency is to hold a railroad company liable for medical services rendered in emergency at the request of an employee to servants of the company or passengers injured on the road. Thus in *Toledo &c. R. R.* vs. *Rodrigues*, 47 Ill. 188, a contract by a station-master, affirmed by superintendent, for services to a brakeman was sustained. So also if the superintendent do not disaffirm the subordinate's request (*Toledo &c. R. R.* vs. *Prince*, 50 Ill. 26; *Cairo & St. L. R. R.* vs. *Mahoney*, 82 Ill. 73). The power of a railway superintendent or agent to contract for medical services to injured passengers or servants immediately after an accident is implied (*Langan* vs. *G. W. Ry.*, 30 L. T. N. S. 173; *Indianapolis & St. L. R. R.* vs. *Morris*, 67 Ill. 295), but it has been held that a division superintendent cannot bind the road to pay for services to passengers without express authority, although he may do so as to employees (*U. P. R. R.* vs. *Beatty*, 35 Kan. 265; *Brown* vs. *Mo. K. & T. R. R.*, 67 Mo. 122; *Terre Haute & I. R. R. Co.* vs. *McMurray*, 98 Ind. 358); and even as to employees it is held in Arkansas that except in emergency a conductor cannot without express authority bind the road (*St. L. A. & T. R. R.* vs. *Hoover*, 53 Ark. 377). As to nurses, it is said that a railroad surgeon has no power to employ them (*Bigham* vs. *Ch. M. & St. P. R. R.*, 79 Iowa, 534), otherwise of a "general manager" (*Louisville E. & St. L. R. R.* vs. *McVay*, 98 Ind. 391; and see *Mayberry* vs. *Ch. R. I. & P. R. R.*, 75 Mo. 492; and *Cin., Ind., St. L. & Ch. R. R.* vs. *Davis*, 126 Ind. 99).

family doctor from fear of neighborly criticism, although when the attending physician asked for a consultant the patient answered, "You'll do," and only assented on the doctor's promise to pay the consultant's fee. The grounds of the decision were, of course, that the patient accepted the service, and that the consultant did not know that he was called for the benefit not of the patient but of the doctor.*

Although there may be no doubt as to who, if any one, is liable under the original contract, there may be other reasons for refusing to pay for medical attendance. It has been said already that where license and registration laws exist compliance with their provisions is a condition for suing to recover fees. In England proof of qualification must be made as part of the plaintiff's case;† but in this country, unless the contrary appear, it will generally be presumed that plaintiff's practice was lawful.‡ In a New York case under the old statute, which only required a physician to file a copy of his license with the county clerk under penalty of twenty-five dollars for failing to do so, but did not prohibit those not complying with the requirement from practicing, it was held that an action for fees could be maintained by one who had not filed his license; the forfeiture being the sole punishment prescribed for the omission.§ But where practice by the unlicensed is forbidden a contract to pay fees is void, and the fees cannot be recovered by the practitioner even though he subsequently become licensed‖ or the statute be repealed.¶ Nor can an illegal practitioner sue on notes given for his services.** But even where the statute forbade unlicensed practitioners to sue for fees, it was held that a licentiate might recover compensation for the services of his students and assistants.†† And in England it was said that an unregistered assistant might sue a registered practitioner for salary, although an unlicensed practitioner might not sue a registered practitioner for services rendered to the latter's patients at his request;‡‡ and a physician may sue in a State where he is not licensed for services lawfully rendered in another State.§§

* *Shelton* vs. *Johnson*, 40 Iowa, 84; cf. *Garrey* vs. *Stadler*, 67 Wis. 512.

† *Morgan* vs. *Ruddock*, 1 H. & W. 505; *Sharpe* vs. *Wagstaffe*, 3 M. & W. 521.

‡ *Thompson* vs. *Sayre*, 1 Den. 175; *McPherson* vs. *Cheadell*, 24 Wend. 15; *City of Chicago* vs. *Wood*, 24 Ill. Ap. 40. The English rule seems to be better founded since to disprove the license is to maintain a negative, and in *Adams* vs. *Stewart*, 5 Harr. (Del.) 144, it was followed.

§ *Finch* vs. *Gridley's Excrs.*, 25 Wend. 469.

‖ *Puckett* vs. *Alexander*, 102 N. C. 95; 8 S. E. 767; *Thompson* vs. *Hagen*, 25 Mo. 104; *Gardner* vs. *Tatum*, 81 Cala. 370; 22 Pac. 880. The English rule seems to be that it is enough if the practitioner be *registered* at the time of trial: *Turner* vs. *Reynall*, 8 L. T. R. 281. But he must be *qualified* when the service is rendered: *Leman* vs. *Housely*, 31 L. T. 833.

¶ *Bailey* vs. *Mogg*, 4 Den. 60; *Warren* vs. *Saxby*, 12 Vt. 146. But if the statute does not forbid the practice, but only forbids collecting fees by action, one may sue after its repeal: *Hewitt* vs. *Wilcox*, 42 Mass. (1 Metc.) 154.

** *Coyle* vs. *Campbell*, 10 Ga. 570.

†† *People ex rel Waring* vs. *Monroe*, C. P. 4 Wend. 200. And he may recover for his assistants: *Board of Commrs. of Jay Co.* vs. *Brewington*, 74 Ind. 7.

‡‡ *De La Rosa* vs. *Prieto*, 10 L. T. 757. The test seems to be that the services of the unregistered assistant, to be lawful, must be given under the supervision of the qualified practitioner and not independently. See *Howarth* vs. *Brearly*, 56 L. T. 743; *Davies* vs. *Makuna*, 53 L. T. 314.

§§ *Downs* vs. *Minchew*, 30 Ala. 86.

The contract being, as we have seen, to furnish ordinary skill, knowledge, and diligence, and not to guarantee a cure, and no presumption of its breach arising merely from a mistake in diagnosis,* it follows that death or any other bad result does not *per se* constitute a defense to an action to recover compensation for services. Thus, if a surgeon operate upon a married woman under his care, without assent of the husband or notice to him, and the patient die, it is not necessary in suing for his fees that the surgeon prove that the operation was well done, and with notice to the husband.† That the treatment or operation was ill done, harmful, or unnecessary is an affirmative defense in such an action, and the burden of proof is on the defendant.‡ If the defense be negligence of nurses, as in a hospital, plaintiff may show that they were not under his control.§ There is a comfortable Georgia case wherein the patient sought to evade paying his doctor on the ground that the latter tippled; but this was held to be no defense, because defendant employed the doctor with knowledge of his habit.‖ In charging fees the means of the patient may properly be considered.¶ But an East Indian case holds that in estimating the remuneration of a medical officer for attending the family of a public servant the patient's prospects cannot be considered; and one fifth of the patient's monthly income was said to be a fair sum for the year's attendance.** A physician may show his own high standing as well as the difficulty or novelty of the operation as bearing on the value of his services.†† In the absence of proof altering its effect a receipt in full for medical services will be the measure of their value.‡‡ Sometimes the humble name of wages may save the fees; as where a physician's compensation of thirty dollars a day for fifty-six days' attendance on city smallpox patients paid in one sum was held exempt from garnishment as "wages" for personal services.§§ A physician cannot show discoveries, in skin-grafting, for instance, made while attending a case, in order to enhance the value of his services; nor can he offer evidence as to the treatment of a physician subsequently employed.‖‖ In dealing with municipal organizations the physician should be wary. Where a statute permitted trustees of a town to pay for such medical relief rendered to the poor as "they deemed just and reasonable," their opinion as to the value was held to be the limit of recovery, and their rejection of a claim as unjust and unreasonable, to be final.¶¶ It was held that a physician

* *Ely* vs. *Wilbur*, 49 N. J. L. 685; 10 Atl. 358; *Lawson* vs. *Conaway*, 37 W. Va. 159.

† *State* vs. *Housekeeper*, 70 Md. 162; *McClallen* vs. *Adams*, 36 Mass. (19 Pick.) 333.

‡ *Baird* vs. *Morford*, 29 Iowa, 531. See under malpractice, *infra*.

§ *Baker* vs. *Wentworth*, 155 Mass. 338; 29 N. E. 589; *Perionowsky* vs. *Freeman*, 4 F. & F. 977. But he is liable for unskillful acts of his authorized assistant: *Hancke* vs. *Hopper*, 7 C. & P. 81.

‖ *McKleroy* vs. *Sewell*, 73 Ga. 657.

¶ *Czarnowski* vs. *Zeyer*, 35 La. An. 796. And also unusual services: *Succession of Short*, (La.) 14 So. 184.

** 2 Agra. 51.

†† *Lange* vs. *Kearney*, 4 N. Y. Supl. 14; 45 Hun, 590; 127 N. Y. 676.

‡‡ *Danziger* vs. *Hoyt*, 46 Hun, 270; afd. 120 N. Y. 190. And the amount stated in a bill rendered is not binding if not assented to by the patient: *Bronson* vs. *Hoffman*, 7 Hun, 674.

§§ *Sydnor* vs. *City of Galveston*, 15 S. W. 202.

‖‖ *Gardner* vs. *Tatum*, 81 Cala. 370; 22 Pac. 880.

¶¶ *Trustees of Elizabeth Township* vs. *White*, 48 Ohio St. 577.

summoned to make an autopsy could not recover a fee from the county in the absence of a statute authorizing the expense.* And where at a coroner's request a physician made the autopsy and afterward sued for his fees, it was held that the measure of value was what his services were worth in the particular case; and the amount of his daily earnings or what another physician would charge were alike immaterial.† But under the Colorado statute providing that, if the jury think it necessary, the coroner may summon a physician to make an autopsy, for which the county shall pay a reasonable fee, it is not essential in an action for such fee that the plaintiff should prove that the jury thought the autopsy necessary; proof of the summons and rendition of services are sufficient.‡

Medical services rendered in emergency to a poor person not judicially declared to be a pauper have been considered not to be a county charge, but to have been rendered, presumably, for charity;§ a different presumption from the quaint opinion of the court in Rose's case, *supra*: "Therefore let the distemper be what it will, the prescribing and advising what is fit for it is the business of the physician, *though without a fee; but that rarely happens.*" ||

The rule as to the fees of expert witnesses varies with the jurisdiction. In New York, although under the general subpœna a physician must of course appear in court and testify to facts of the case within his ordinary observation, he will not be compelled to give his opinion on matters of skill and science. And therefore it is proper for district attorneys to employ medical experts on behalf of the people. The fact that an expert has received a large fee does not make his testimony incompetent or afford ground for a new trial.¶ But this rule of compensation is not the same, however, in all jurisdictions, and the contrary was held in a laboriously argued Alabama case.** Some States have regulated the matter by statute. Thus, in Minnesota, the judge is authorized to allow an expert witness "such fees or compensation as may seem just and reasonable," and it might seem, therefore, that such a witness might refuse to testify until he received at least the promise of what *he* thought a just and reasonable fee. But the Supreme Court held, approving the reasoning of *ex parte* Dement,** that this provision of law had reference to an allowance to be made after the witness had been dismissed, not before.†† In Colorado, if the expert witness testifies under subpœna without making an agreement in advance for his compensation, he is only entitled to statutory fees.‡‡ The Indiana Code of Civil Procedure provides for compelling an expert witness to testify without extra compensation.§§ But prior to the enactment of this rule in 1881, the courts of

* *Fears* vs. *Nacogdoches Co.*, 71 Tex. 337; 9 S. W. 265.

† *Marion County Commissioners* vs. *Chambers*, 75 Ind. 409.

‡ *Pueblo Co.* vs. *Marshall*, 11 Col. 84; 16 Pac. 837.

§ *Cantrell* vs. *Clark Co.*, 47 Ark. 239; 1 S. W. 200; cf. *Miller* vs. *Inhabitants of Somerset*, 14 Mass. 397.

|| 3 Salk. 17; 6 Mod. 44, *supra*.

¶ *People* vs. *Montgomery*, 13 Ab. Pr. (N. S.) 207; cf. *in re* Roelker, 1 Sprague (U. S.), 276; *semble*, that in case of necessity the court might compel testimony.

** *Ex parte* Dement, 53 Ala. 389.

†† *State* vs. *Tiepner*, 36 Minn. 535; 32 N. W. 678.

‡‡ *Board of Commissioners of Larimer County* vs. *Lee*, 32 Pac. 841.

§§ Rev. Sts. Indiana, § 504; Code, § 282.

that State had laid down the same rule as in New York.* The English rule is that one called as a witness to give his opinion on a subject with which he is peculiarly conversant from his employment in life is not bound to testify unless the party calling him "pay for his time."† And in a comparatively recent case an auctioneer was said to be a professional witness and not bound to testify even if sworn, until his fee, expenses, or compensation for time, at a guinea a day, were paid.‡

A contract whereunder the compensation of the witness is contingent upon the success of the side for which he is called is void as against public policy.§ Mr. James Summers, of Texas, killed Benito Martinez, of Nueces, in a peculiarly dastardly fashion while the latter was kneeling to strike a match. He was convicted of murder in the second degree, and sentenced to imprisonment for ninety-nine years. On the trial Dr. Spohn, who attended on decedent and made an autopsy, was called by the prosecution, but refused to state the cause of death, because, in the words of the report, "what he knows of it he got by means of a post-mortem examination and his professional skill and deduction of experience, which witness considers his own property, and for which the county of Nueces persistently refuses to pay." The Trial Court upheld the doctor in this position. But the thrifty prosecution, instead of paying the expert, called Mr. Charles Benson, who, although he "knew nothing of the science of surgery or anatomy," had served at the inquest and testified as to the fractures of Benito's skull which the doctor pointed out to him. The Appellate Court held that Dr. Spohn could not have been compelled to make a gratuitous autopsy for the people; but having already made one for his own enlightenment, he was bound to testify concerning it; and the court said: "It is to be regretted that a member of a profession so distinguished for liberal culture and high sense of honor and duty should refuse to testify in a cause pending before the courts of his country, involving the life or liberty of a fellow-being, and the rightful administration of the laws of a common country. Dr. Spohn has doubtless been misled, in taking the position he did, by the misconceptions of certain writers on medical jurisprudence." This saying of the court prettily illustrates how thankless it is for a text-writer to angle in the chopping sea of judicial decisions for a rule of general utility. However, Mr. Summers did not escape judgment, for the Appellate Court sagely held that, although the Trial Court erred in not compelling Dr. Spohn to testify gratuitously, still this error was offset by the error of defendant's counsel in not themselves calling Dr. Spohn and either paying him or taking an exception if he was permitted to refuse to testify. Errors being thus evenly distributed between bench and bar, not to speak of text-writers, honors were considered easy, and, as a result, so far as the record shows, Mr. Summers is now serving his sentence, which

* *Buchanan* vs. *State*, 59 Ind. 1.

† *Webb* vs. *Page*, 1 C. & K. 23.

‡ *Re* Workingmen's Mutual Soc., L. R. 21 Ch. D., 831; but scientific experts who have made experiments for the trial are not professional men, within the rule. They are entitled to seven guineas a day for loss of time in reading over affidavits; but the party calling them must pay for their experiments. See *Practice Relating to Witnesses*, Walter S. Sichel, London, 1887.

§ *Pollock* vs. *Gregory*, 9 Bos. 116.

will not expire until A.D. 1978, and the county
refuses to pay" Dr. Spohn even to this day.*

Despite every precaution it sometimes occ
leaving his doctor unpaid and executors who
then where the plaintiff is forbidden, as in New
own behalf, unless the executor so testify in be
of the services must be made otherwise than
mony, and may be difficult.

In New York and in some other States, if a p
ment for his fees even by default in appearance
action by defendant for malpractice, for the n
to the former action;‡ but in other States this
the extent that a judgment upon the merits is s
one taken on default in appearance.§

Professional Confidences.—At common la
tween client and legal adviser necessary to the
tion were held to be confidential and protected
similar communications between parishioners
physicians, were not so privileged. The differ
equally sacred confidences by the "eye of the la
spoke so feelingly, has been said to be due not
in the relation of counsel and client, nor to any
gentlemen of the bar, but to the fact that ow
the laws it is necessary for clients to consult
order to obtain their rights, and unless this cons
the ends of justice are likely to be defeated.
which is the client's, extends only to communica
cise matter on which advice is sought and in t
ment: it is also perpetual, and can only be wai
the confidence. But matters confided to the m
by him, apart from confidential communicatio
employment, are not privileged, even though he
of them except for the professional relation.
forbids extending this privilege to either commu
of a criminal purpose or facts showing the con
the employment of the legal adviser.||

In England the question whether a clergy
Catholic priest, may be compelled to disclose
still open.¶ But in the Duchess of Kingston's
been followed in others, it was held that a surg
court professional confidences to reveal which v

* *Summers* vs. *The State*, 5 Tex. Ap. 365.

† Code of Civil Procedure, 829; *Ross* vs. *Ross*, 6 Hun,

‡ *Blair* vs. *Bartlett*, 75 N. Y. 150.

§ *Goble* vs. *Dillon*, 86 Ind. 327; *Lawson* vs. *Conaway*,
treatises of Messrs. Bigelow and Herman on estoppel.

|| Greenleaf on Ev., ed. of 1892, ss. 237–248. Bes
Steph. *Dig.*, Art. 115.

¶ Steph. *Dig.*, Appendix, note xliv.; *Broad* vs. *Pitt*, 3
said that such communications were not privileged, but
clergyman to reveal what a prisoner had told him, alt
voluntarily offered in evidence.

** 20 How. St. Tr. 355, at p. 573.

Lord Mansfield, "to be guilty of a breach of honor and of great indiscretion." This rule of common law has been pronounced by Mr. Best, in his treatise on evidence, to be "harsh in itself, of questionable policy, and at variance with the practice in France and some of the United States of America."* Legislation in this country to protect confidences between patient and physician has been enacted for the most part in those States where, as advocates of codification think, "common sense" is most wont to assert itself against outgrown traditions of common law; in New York, followed by Arkansas (the United States Court in the Indian Territory follows Arkansas Civil Procedure), California, Colorado, North and South Dakota, Idaho, Iowa, Indiana, Kansas, Michigan, Minnesota, Missouri, Montana, Nebraska, Nevada, Ohio, Oklahoma, Oregon, Utah, Washington, Wisconsin, and Wyoming.

The extent of the protection thus afforded must depend in every jurisdiction upon the words of the statute and the construction given to them by the courts. But the general statutory rule is substantially that enunciated in the New York Code of Civil Procedure, viz.: "A person duly authorized to practice physic or surgery shall not be allowed to disclose any information which he acquired in attending a patient in a professional capacity."† On the face of this law the privilege and duty belong only to those duly authorized to practice. And a communication to an illegal practitioner,‡ or to a layman sharing a physician's office,§ is not within the statute. At the same time, when a medical practitioner has testified, unless his disqualification appear he will be presumed to be licensed.‖ It is not all the knowledge a physician possesses concerning a patient that he is forbidden to reveal, but only information acquired by and imparted to him in treating the case and for that purpose. Thus, the issues being testamentary capacity and undue influence, a contestant of the will cannot introduce testimony of the decedent's physician as to knowledge acquired by the latter in his professional relation.¶ But it is otherwise as to a physician's testimony regarding matters not learned professionally, and obvious to any intelligence.** Therefore, a physician who has seen his patient often socially

* Best, *Pr. of Ev.*, 582.

† N. Y. Code Civ. Pro., § 834. Such provisions of State law will be enforced in the Federal Courts in civil actions. *Conn. Mut. Life Ins. Co.* vs. *Union Trust Co.*, 112 U. S. 250; but not in criminal actions: *Logan* vs. *U. S.*, 144 U. S. 263. The original section of the N. Y. Rev. Statutes has been the model of all State legislation on this subject. But the phraseology of various statutes differs, and is always subject to change. In several States the privilege only exists in civil cases. Some statutes use the terms "practicing," "licensed," "authorized," "regular" physicians. Each statute must be consulted as to cases arising under it. But the decisions of the New York Court of Appeals have been followed as authority in almost every decided case throughout the country.

‡ *Wiel* vs. *Cowles*, 45 Hun, 307.

§ *Kendall* vs. *Grey*, 2 Hilton, 300.

‖ *Record* vs. *Village of Saratoga Springs*, 46 Hun, 448; afd. 120 N. Y. 646.

¶ *Renihan* vs. *Dennin*, 103 N. Y. 573. Matter of Coleman, 111 N. Y. 220; *Van Orman* vs. *Van Orman*, 11 N. Y. Supl. 931, and cases collected in note; and see recent amendments to the N. Y. Code *infra*.

** *Herrington* vs. *Winn*, 14 N. Y. Supl. 612; 60 Hun, 235. *In re* Halsey's Estate, 9 N. Y. Supl. 441. Whether in an action to recover damages for negligence plaintiff's physician can testify to statements of his patient as to how the accident happened, has been decided in both ways. In *Brown* vs. *Rome, W. & O. R. R. Co.*, 45 Hun, 439, plaintiff's physician was held competent to testify that the patient said he heard some one halloo and wave his hat as the train which injured him came along. But in *Penna. Co.* vs. *Marion*, 123 Ind. 415, 23 N. E. 973, the contrary was held; and in

may testify as to his opinion of her mental state, from knowledge acquired outside the professional relations, if he can exclude from his mind in answering the questions all information acquired in the course of his attendance.* How far such separation of the data acquired in the diverse social and professional relations can be effected in any given case must necessarily be largely determined by the physician's conscience; but if he cannot make such separation his testimony on the point must be excluded.† Where the attorney of a testatrix, without her consent, called in to examine her mental condition a physician who, without prescribing or being recognized by her as a medical attendant, subscribed her will as a witness at her request, it was held on the probate that the physician's testimony as to her mental state was competent evidence.‡ So an attending physician may testify both as to his patient's declarations as to the will and his own advice concerning it; § and also generally as to the value of the services of a nurse, in an action brought by the latter to recover compensation from the patient's estate.‖

If objection is made to a physician's testimony that it relates to knowledge gained in his professional capacity, the burden of proving this is upon the objector.¶ The limitations of the privilege under the New York Code have been exhaustively discussed by the Court of Appeals, notably in the cases of *Edington and Grattan* vs. *The Insurance Companies*;** and it may be considered as settled that the patient's privilege extends to all information acquired by the physician in his professional attendance, whether personally observed by him in examining the patient, or imparted to him by any one in order to enable him to act in his professional capacity; and that, too, although it might not, in fact,

Kling vs. *City of Kansas*, 27 Mo. Ap. 231, a physician was not allowed to testify that his patient had been drinking; while in *Cooley* vs. *Foltz*, 85 Mich. 47; 48 N.W. R. 176, the physician was allowed to say that the patient stated that she would sue the company and wanted him as a witness; and that plaintiff's refusal to call him was proper subject of comment to the jury; cf. *Gartside* vs. *Ins. Co.*, 76 Mo. 446 (see note also); *Linz* vs. *Ins. Co.*, 8 Mo. Ap. 363; *Streeter* vs. *City of Breckenridge*, 23 Mo. Ap. 244; *Norton* vs. *Moberly*, 18 Mo. Ap. 457. In *Collins* vs. *Mock*, 31 Ark. 684, the physician was allowed to testify that his patient admitted that she had never been engaged to marry her child's father.

* *Fisher* vs. *Fisher*, 129 N. Y. 654.

† *In re* Darragh's Est., 52 Hun, 591. In insurance cases it has been held that an attending physician may testify to the fact that he attended decedent at certain times and places, though he may not testify as to what he learned in so doing: *Numrich* vs. *Supr. Lodge K. & L. of Honor*, 3 N. Y. Supl. 552; *Patten* vs. *United L. & Ac. Ins. Ass'n*, 133 N. Y. 450; *Breisenmeister* vs. *Knights of Pythias*, 81 Mich. 525. In Missouri it is held that the facts showing inability to separate knowledge acquired professionally from other information must be stated; *Gartside* vs. *Ins. Co.*, 8 Mo. Ap. 593; afd. 76 Mo. 446, *supra*; and also that the witness's incompetency must affirmatively appear: *Bowles* vs. *Kan. City*, 51 Mo. Ap. 416.

‡ *In re* Freeman, 46 Hun, 458.

§ *In re* O'Neill's Est., 7 N. Y. Supl. 197.

‖ *Pandjiris* vs. *McQueen*, 13 N. Y. Supl. 705; not as to particulars affecting the patient: *Burley* vs. *Barnhard*, 9 N. Y. St. 587.

¶ *Stowell* vs. *Amer. Coöp. Relf. Ass'n*, 5 N.Y. Supl. 233. As to when the objection is to be made, see *Feeny* vs. *L. I. R. R. Co.*, 116 N.Y. 375; cf. *Hoyt* vs. *Hoyt*, 112 N.Y. 493.

** *Edington* vs. *Mutual Life Ins. Co.*, 67 N. Y. 185, revg. 5 Hun, 1; *Edington* vs. *Ætna Life Ins. Co.*, 77 N. Y. 564, revg. 13 Hun, 543; *Grattan* vs. *Met. Life Ins. Co.*, 80 N. Y. 281; *Renihan* vs. *Dennin*, 103 N. Y. 573; *Feeny* vs. *L. I. R. R. Co.*, 116 N. Y. 375; *in re* Darragh's Est., 52 Hun, 591; *Sloan* vs. *N. Y. C. R. R.*, 45 N.Y. 125; and cf. *Patten* vs. *United L. and Ac. Ins. Ass'n*, 16 N. Y. Supl. 376; revd. 133 N. Y. 450; *Numrich* vs. *Sup. Lodge K. & L. of Honor*, 3 N. Y. Supl. 552; *Briggs* vs. *Briggs*, 20 Mich. 34; *Penna. Co* vs. *Marion*, 123 Ind. 415; 23 N. E. 973; *Kling* vs. *City of Kansas*, 27 Mo. Ap. 231; *Brown* vs. *Rome, W. & O. R. R.*, 45 Hun, 439.

aid him to prescribe; for it is obvious that the value of information imparted to physicians by the laity cannot be known until the communications are made. Any narrower construction of the statute than this would defeat its purpose, to remedy the defect of the common law by making absolutely confidential all communications to the physician in reference to the patient's case. The test, therefore, of the admissibility in evidence of any communication to a physician seems to be, Was it made with intent to assist him in treating the case?* A learned judge of the New York Court of Appeals strenuously argued in *Edington* vs. *Ætna Life Insurance Co.*,† that the statute conferring this privilege, being a departure from the common law rule, should be strictly construed to prohibit the disclosure by a physician only of information of a confidential nature obtained from the patient during professional attendance, but not to exclude testimony as to matters which were obvious to all; as in the case of a maniac, or one suffering from a fractured leg. He again urged this view in *Grattan* vs. *Insurance Co.*,‡ but the court having elected to interpret the statute liberally as a remedial act, the same judge in *Renihan* vs. *Dennin*,§ after stating his own previous opposition to the establishment of the rule, declared it to be settled that the statute is not confined to information of a confidential nature, but covers all information acquired by a lawful practitioner while attending a patient professionally, and necessary to enable him to act in the professional capacity; and also that the privilege extends to probate proceedings and to information acquired by a physician called in consultation.

Where the privilege is held to exist the rule is rigorously enforced. Thus, where a physician was examined as a debtor in supplemental proceedings, an exhibition of his account-books containing information as to his patients' maladies was not permitted.‖ In an action for divorce for adultery, a physician's testimony as to conversations and circumstances tending to establish the adultery was held inadmissible.¶ But where the prohibited testimony has been received without objection, even though a motion be made to strike it out, it will be considered on appeal.**

In Indiana a physician was not permitted to testify as to what he had learned of the condition of his partner's patient, who came to their office for treatment;†† and in New York, on an application for a committee for an habitual drunkard, an affidavit of the patient's physician in support of the application was held to be incompetent evidence.‡‡ It is not, however, every act of medical attendance that creates the confidential relation and consequent privilege. Thus it seems that casual advice to a friend is

* Matter of Darragh, *supra*.

† 77 N. Y. 564; cf. *Linz* vs. *Mass. Mut. Life Ins. Co.*, 8 Mo. Ap. 363; disapproved in *Kling* vs. *City of Kansas*, 27 Mo. Ap. 231; *Gartside* vs. *Ins. Co.*, 76 Mo. 446.

‡ 80 N. Y. 281.

§ 103 N. Y. 573; cf. cases cited in *Breisenmeister* vs. *Knights of Pythias*, 81 Mich. 525.

‖ *Kelly* vs. *Levy*, 8 N. Y. Supl. 849. And where a physician sued for damages for personal injuries an examination of his books was refused to defendant: *Mott* vs. *Consumers' Ice Co.* 2 Ab. N. C. 143; 52 How. Pr. 148, 244.

¶ *Hunn* vs. *Hunn*, 1 Th. & C. 499; *Briggs* vs. *Briggs*, 20 Mich. 34; *Hanford* vs. *Hanford*, 3 Edw. Ch. 468.

** *Hoyt* vs. *Hoyt*, 112 N. Y. 493; *Johnson* vs. *Johnson*, 14 Wend. 637, revg. 4 Paige 460; but see note * p. 631.

†† *Ætna Ins. Co.* vs. *Deming*, 24 N. E. 86, 375; 123 Ind. 384; cf. *Raymond* vs. *B. C. R. & N. Ry. Co.*, 65 Iowa, 152.

‡‡ *In re* Hoyt, 20 Ab. N. C. 162.

not professional attendance within the meaning of insurance policies.* And where an attending physician, solely with a view to obtaining or excluding the expert testimony of a surgeon, asked the latter to examine the condition of his patient, the plaintiff, the surgeon, was held to be a competent witness for the defense as to the true condition of plaintiff; this upon the ground that the surgeon *was not expected to and did not treat or prescribe for plaintiff or advise as to his treatment.*† This case does not seem to have been carried up to the Court of Appeals or ever to have been cited as an authority, nor does the opinion of the General Term cite any authority in support of the position that an examination by a surgeon with a view to informing the patient of his condition will not be considered professional attendance, in the absence of proof of a request or expectation that the surgeon should also treat the case. If treatment or the expectation thereof be the test of the privilege, then if A, desiring to satisfy himself of his physical condition, either, as often happens, to verify the report of an insurance company's examiner or for any other cause, submit himself to B for examination, there is no such professional relation between A and B as the statute contemplates. It may well be doubted if this construction of the law would be sustained on appeal; nor does it seem to be in harmony with the rule in the matter of Darragh, where the court said: "It is so difficult to draw the line that it is certainly best to err upon the side of safety, and shut the door against all disclosures of information acquired by a physician in attending a patient in a professional capacity, without requiring absolute proof that such information was necessary to enable him to act in that capacity."‡ Moreover, if forming a professional opinion and making a diagnosis and report is not "acting in a professional capacity" quite as much as advising the patient to take daily exercise, it is difficult to know just how to characterize such action. Would the court forbid a pathologist to disclose the result of his expert examination of epithelial tissue with reference to informing the attending physician of the true nature of the disease? Beyond any doubt such a revelation without the patient's permission would violate the spirit of the statute; and yet the pathologist, not being expected to treat the case, would not be, under the test applied in Henry's case, in "professional attendance"; but surely he should not be free to testify that the patient's disease was of syphilitic origin. It is very certain that neither in Henry's case nor the case just supposed would the patient have submitted his condition to expert examination except in the belief that the knowledge so acquired by the medical men would be privileged. To argue otherwise is to err upon the side of danger, and to defeat the benign purpose of the statute. But where defendant sends a physician to examine a plaintiff with a view to procuring information as to his condition, the former may testify to the information so acquired, unless the contrary has been stipulated or the patient has been deceived as to the physician's relation to him.§

* *Gibson* vs. *Am. Mu. Life Ins. Co.*, 37 N. Y. 580; *Edington* vs. *Mutual Life Ins. Co.*, 5 Hun, 1 (reversed on another point, 67 N. Y. 185); *quære*, however, if a confidential communication to such a one is not privileged; it certainly should be.

† *Henry* vs. *N. Y. L. E. & W. R. R.*, 57 Hun, 76; 10 N. Y. Supl. 508.

‡ 57 Hun, at p. 593. In *Renihan* vs. *Dennin*, 103 N. Y. 573, it is held that the privilege exists as to a consultant called in by an attending physician.

§ *Heath* vs. *Bwy. &c. R. R.*, 8 N. Y. Supl. 863. *Aliter* if he is sent at plaintiff's request to act as physician. *Freel* vs. *Cable Ry. Co.*, 97 Cala. 40; 31 Pac. 730.

The modern tendency is to apply the same rules of evidence to criminal as to civil cases, and in some jurisdictions there are special enactments to this effect.* Even in the absence of such legislation the privilege of professional confidences has been held to exist in criminal cases. In the leading case of *People* vs. *Stout*,† the defendant was in jail under a charge of murder. On his person were injuries of a nature to be sustained in a struggle. Two physicians went to his cell, stating that they had been requested by the coroner to examine him. They felt of his pulse, looked at his tongue, and acted as physicians are wont to act. But they did not prescribe or intimate that they would do so. Being asked if the prisoner from their manner had reason to and did think that they were physicians examining him with a view to treatment, one of them answered affirmatively, assigning as his reasons for this opinion their manner, the "entire submission, willingness, and readiness of the prisoner to do what was asked of him," and his inquiry, when they went away, if they would call on the morrow. The court, in a carefully reasoned opinion, held that although the confidential relation of physician and patient did not, technically, exist upon these facts, nevertheless its existence is not indispensable where there is "a state of circumstances which falls short of constituting this technical relation, but which presents a very proper case for the application of the statute." They were, therefore, "of opinion that in a case in which a physician has attended upon a person, under circumstances calculated to induce the opinion that his visit was of a professional nature, and the visit has been so regarded and acted upon by the person, the relation of physician and patient contemplated by the statute may be said to exist. The spirit of the statute is thereby respected, and no great violence is done to its literal terms." Accordingly, the testimony of the physicians as to the prisoner's physical condition was excluded.

The question again arose upon a different state of facts in *People* vs. *Murphy*.‡ Defendant was jointly indicted with a physician for procuring an abortion. The district attorney sent to attend the girl upon whom the abortion was procured a physician who, first having told her that he was sent by the public prosecutor, undertook her case and prescribed for her. Upon the trial his testimony was objected to, but the Trial Court admitted it, being of opinion that the district attorney having employed the witness might waive the privilege. The Court of Appeals, however, reversed the judgment, and held that the relation of physician and patient clearly existed, that the communications of the girl to the physician were privileged, and "that the exception to his disclosure of what he learned while thus in professional attendance was

* N. Y. Code of Crim. Pro., § 392.

† 3 Park. Cr. R. 670. Prior to this case it had been held, in *Hewitt* vs. *Prime*, 21 Wend. 79, an action by a father against his daughter's seducer for loss of the girl's services, that the seducer's consultation with a physician with a view to have an abortion procured was not privileged, because it was, to say the least, doubtful if the relation of physician and patient existed, and also because the information imparted was not necessary to enable the physician to prescribe. The question was raised in an Iowa breach of promise case whether the privilege could be invoked to protect a communication made with criminal intent, and a physician was asked if plaintiff had not consulted him with a view to having an abortion performed. But the court did not decide the point, holding that to submit to an abortion might be not criminal but necessary, and would be presumed innocent in the absence of proof of criminal purpose: *Guptill* vs. *Verback*, 58 Iowa, 98.

‡ 3 N. Y. Cr. Rep. 338; reversed 101 N. Y. 126.

well taken." Here it will be observed that th
not raised by the patient, who was not on tri
to speak, a co-conspirator with her in the c
dicted. The court, having previously held i
will be discussed presently, that the statute co
tect a criminal, now distinguished that case fr
ground that Pierson's victim was dead, and
his privilege as to communications to the phy
dition, in which, moreover, there was nothing
quently to allow one charged with his murd
statements going to show the cause of death w
solely to shield him who had wronged the pati
the patient himself. In the Murphy case, on
whom the abortion was performed was alive,
capable of waiving her privilege, which, being
vent the disclosure of a very discreditable an
on her part. In the case of *People* vs. *Kemmle*
by the prosecution to defendant's cell to exa
his sanity. They were allowed to testify to
mental condition. The report, unlike that i
show very satisfactorily the nature of their int
but their testimony was said to be "to the
ing in the prisoner's physical make-up upo
prisoner's unsoundness of mind could be b
opinion that he was able to distinguish betw
that his conduct on the fatal morning, and su
sciousness of the nature and quality of his act
vs. *Stout, supra,* was distinguished on the gr
visiting physicians attended and prescribed f
they were allowed to describe his condition.
court seems to have fallen into error. For
shows that although Dr. Langworthy, the ja
the prisoner and told him what he expected
visit of Drs. Montgomery and Avery, the last
request of the coroner to examine defendant
to their relation to the prisoner the court dist
prescription made and no conversation abo
gist of Stout's case is in these words of the o
mind had been carefully disabused at the o
examination being solely for his benefit, a
advised that its sole object was to procure e
terrible crime of which he was suspected, the
pretense for the position of his counsel. But
to satisfy us that he regarded the visit very di
for so doing, we feel bound in a case like thi
dearest earthly rights of a man, to show all r
as to the law and fact."

The same point was considered in *Peopl*

* 79 N. Y. 424. † 119 N. Y. 580.

‡ 137 N. Y. 570. Cf. *People* vs. *Glover*, 71 Mich. 3
been told that the physician came from the district a
submitted to examination, the physician's testimony

the prosecution called a physician who, having been sent by the district attorney to see the prisoner, Sliney, testified, as summed up in the report: "That he entered into conversation with the prisoner for the purpose of ascertaining his mental condition; that during the interview the defendant gave him a long account of how he and deceased had had an altercation and a struggle, in which he struck him with a cleaver, but did not know that he had killed him." This is all that can be learned from the report of the circumstances attending the interview between the witness and the prisoner; and of the objection to the testimony the court said: "The objection to this evidence went to its competency, as disclosing a communication from patient to physician, which is privileged under the statute. The answer is that no such relation existed. The physician was sent by the prosecuting authority to make a report upon the sanity of the prisoner. He acquired no information while attending a patient, and was not acting as the professional adviser of defendant." It appears, therefore, that while the case of *People* vs. *Stout* has never been reversed, overruled, disapproved, nor yet expressly limited, still the subsequent cases have not laid down the rule so broadly. Thus, in *People* vs. *Schuyler*,* the prosecution called as an expert witness on the point of defendant's mental condition the physician of the jail, who testified that he had medical charge of all the prisoners, had examined and "kept his eye on" defendant at the request of both sides, that he assumed the obligation of attending the prisoner, and "saw to the defendant as he did to the others, when he needed it." He further testified that, in answering the prosecution's hypothetical question five pages in length, it was practically impossible to divest his mind of the knowledge he had obtained of the prisoner while in jail; and asked, therefore, that his answer might be withdrawn. But the majority of the Appellate Court held that the proof did not show that the relation of physician and patient existed, that the burden of establishing the existence of that relation and the fact that the information of the witness was acquired in professional attendance was upon the defendant, who had failed to show that the prisoner was ever ill or prescribed for. The court said that the mere facts of witness being the jail physician and defendant a prisoner did not constitute the relation, and even if the witness's answer to the hypothetical question had been influenced by his knowledge acquired by seeing defendant in the jail, it was not for that reason incompetent.† The modern rule as to examining, medically, a prisoner in behalf of the prosecution, seems, therefore, to be that in order to exclude the testimony of a physician or surgeon who has made such examination it must appear affirmatively and clearly that the witness's knowledge has been acquired either in the actual medical treatment of the patient, or under circumstances leading the prisoner to believe that the object of the examination or treatment was to acquire information for the purpose of giving him such treatment.

It has been seen in Murphy's case (*supra*) that a third person may invoke the prohibition of the statute to shield himself against a criminal

* 106 N. Y. 298.

† Rapallo and Andrew, J.J., dissented, the former reading a very cogent opinion in favor of reversal. These recent cases come perilously near to making the accused testify against himself. But where such an examination was procured by threats, the act was held to be unconstitutional: *People* vs. *McCoy*, 45 How. Pr. 217.

charge, and it is important to ascertain within what limits this may be done. In two cases of murder by poison,* the latter very recent, the testimony of physicians was admitted not only as to the causes of death and the condition in which they found decedents, but also as to statements both of the patients and attendants, and, in the Pierson case, of the defendant as well. Pierson, who was charged with poisoning one Withey, had called Dr. Coe to see the decedent before his death. The physician examined and prescribed for the sick man, and on the trial was allowed to state decedent's symptoms and condition as he found them by examination and as he learned them from defendant and Mrs. Withey, who was jointly indicted with Pierson for the murder. Under the letter of the statute such evidence was clearly incompetent. But the Appellate Courts held that the enactment must be construed with a view to its sole purpose, namely, the protection and welfare of the patient by making confidential all communications to his physician, made with a view to benefit him. And because the court were of the opinion that the exclusion of such testimony as Dr. Coe's would make convictions of poisoners well-nigh impossible, and so be clearly contrary to the spirit and intent of the legislature, it was said by Earl, J., adopting the words of Talcott, J., below: "That in such a case the statute is not to be so construed as to be used as a weapon of defense to the party so charged, instead of a protection to his victim." The court, however, did not think it expedient to lay down a general rule limiting the scope of the statute, but confined their opinion to construing the law in its application to the facts of the case at bar, upon which it was considered that "there was nothing of a confidential nature in anything that he [Dr. Coe] learned or that was disclosed to him." Suppose there had been a confidential disclosure by the prisoner; suppose in a moment of evil impulse he had given the poison, and then, overcome by fear or remorse, had called in medical aid with *bona fide* intent to save his victim, and confessed the method employed in his crime in order that an antidote might be supplied: would there be here a *locus penitentiæ*, and would this confession, made in order to enable the physician to act professionally, be privileged? The Pierson case was decided by the Court of Appeals in the year 1880. In 1889 it was considered by a General Term of the Supreme Court on an appeal from a judgment of conviction of manslaughter in the first degree, in a case wherein the only evidence to sustain the conviction was that of the physician attending decedent in her last moments. He testified, under objection, that he was called to visit the woman by defendant, who, at the same time, in order to aid the physician's diagnosis and treatment, confessed that he had attempted to procure upon her an abortion by an operation, the details of which he described. The General Term held that these facts differed widely from those of the Pierson case, since here defendant felt that the physician ought to know, as in fact it was necessary for him to know, the probable causes of the patient's prostration. And without dissent it was said: "In this critical moment, with the sole purpose of saving the woman's life, he disclosed the secret to the physician to enable him to act rightly. To have withheld the disclosure would have made the defendant a consenting party to the

* *Pierson* vs. *People*, 79 N. Y. 424, affirming 18 Hun, 239; *supra*, p. 22; *People* vs. *Carlyle Harris*, 136 N. Y. 423.

woman's death. We have no doubt that the statute, both in letter and spirit, protects the confidence thus reposed in the physician and forbids him to betray it."* In 1893 came the decision of the Court of Appeals in the case of Carlyle Harris, convicted of murder in the first degree by poisoning his wife. The record showed that the Trial Court received as relevant to the establishment of motive, testimony of decedent's uncle, Dr. Treverton, to the effect that he had operated upon his niece some six months prior to her death, and removed a five months' fœtus. At that time defendant, a medical student, appeared on the scene pursuant to a message from witness, and then said that he had previously performed two operations upon the girl and thought everything was removed. On appeal it was argued that this testimony was incompetent, first, because it was the revelation by a physician of a privileged communication, upon which point the Brower case was cited; and second, because it was proof of a separate crime from that charged. The Court of Appeals, affirming the judgment below, said: "The first ground of objection is untenable for several reasons. In the first place, the witness was not employed by the defendant. In the second place, he acquired no important information from the defendant, or any which he was not already possessed of, or which was necessary for him to act in a professional capacity. Lastly, the statutory privilege was not conferred to shield a person charged with the murder of a patient; as was held in *Pierson* vs. *People*, 79 N. Y. 424. I should never be willing to assent to a construction or to believe in a legislative intent which would operate to convert a statutory provision protecting a patient from a damaging or objectionable disclosure into a protection for a person on trial for the murder of a patient." The last ground for refusing to consider the communication as privileged seems to make the first two unnecessary, and, logically, to imply that even if defendant had employed the witness, and had imparted to him confidential information necessary to enable him to act professionally, still the court would not construe the statute to shelter the prisoner. On the other hand, if Harris had employed his wife's uncle, and had imparted to him confidential and necessary professional information, and if these facts would have been sufficient to exclude the uncle's testimony, as the court's assignment of the first two reasons might imply, then on this point the Harris case would have been on all-fours with *People* vs. *Brower*, and the decision in the latter case is good law; and, if it be good law, then only the spirit of prophecy can determine how the courts will decide if ever there shall be presented to them our hypothetical case of a repentant poisoner turning away from his wickedness and trying to undo his crime. If, however, that supposititious penitent be conversant with medicine and the law reports, he will, unless his conscience is very active, decline to make perilous confidences and seek rather to procure a certificate of peritonitic death.

The purpose of conferring this privilege is clearly set out in the Note of the Revisers of the New York statutes (3 R. S., 2d Ed., 737), who were the originators of the rule throughout the land. It was to enable a patient frankly to disclose his physical condition and history to his medical adviser so as to benefit by his advice without fear of publicity. The privilege is solely for the patient's protection. It is not intended to

* *People* vs. *Brower*, 53 Hun, 217; 6 N. Y. Supl. 730.

keep secret anything that he wished to be public. An over-literal construction of the law begets such *reductiones ad absurdum* as that suggested in Depoister's case:* that if the body of a child *non sui juris*, and therefore incapable of waiving its right, be violated, the offending brute may invoke its privilege to exclude the testimony of the examining physician. It is a fair presumption that in criminal cases every person wronged desires the punishment of the one who has injured him. In theory public safety demands such punishment. Every one who does not thereby incriminate himself must testify against the criminal. Therefore, if the patient be dead, it is fair to presume that, if living, he would waive his privilege and permit his physician to reveal matters not disgraceful to his memory, as in Pierson's case, or even to corroborate disgraceful matter already revealed, as in Harris's case. If the patient be living, and the physician's testimony would add a new evil to that already suffered by him, as in Murphy's case, it seems logical that the privilege should subsist if not expressly waived. In the cases of which Brower's is a type, the arguments seem closely balanced. Yet, applying the test of the patient's wish, no one can doubt but what if the decedent in that case could have spoken, she would have sheltered under her privilege the defendant who made a perilous confession in order to save her life, who, although his victim, was also his willing accomplice in the sorrowful crime. It is more doubtful whether such presumption could arise as to an abortionist for hire.† Doubtless it was a perception of the difficulties of applying such a statute in criminal cases that has led certain States to allow this privilege only in civil actions.

The application of the rule in "accident" and "insurance" cases, also obviously too often serves only to cloak fraud. It needs no argument to show the unfairness, if not dishonesty, as a general rule, of those who bring actions to recover damages for their physical injuries, yet will not permit the best evidence of the nature and extent of those injuries to be put before the jury. The remedy for this evil is to be sought in amendment of the statutes; yet even now it is not so great as it may seem. For to any intelligent jury the fact that one party to the action is suppressing the truth as to the issue must be as convincing of the weakness of his cause as direct testimony, and more prejudicial; and it is in the power of the adverse party by calling the physician and proving his attendance on patient, to demonstrate that if his adversary does not then offer the physician's testimony, it is because he dare not have the whole truth known.

Waiver.—It is a principle of law that any one may waive his own rights and privileges, expressly or by implication. The prohibition to reveal the secrets of the sick-room was early decided to be the privilege of the patient, not of the physician,‡ and therefore after the patient's death neither his executor nor any one else can waive it, a mere succession in property interest not being sufficient to authorize such waiver;§

* *State* vs. *Depoister*, 25 Pac. 1000.

† As this book goes to press the point is before the General Term of the Supreme Court of New York in *People* vs. *Chase*.

‡ *Johnson* vs. *Johnson*, 14 Wend. 637; therefore, if the patient waive the privilege, the court will compel the physician to answer. *Valensin* vs. *Valensin*, 14 Pac. 397; *Penn. Mut. Life Ins. Co.* vs. *Wiler*, 100 Ind. 92. But the physician cannot waive it: *Harris* vs. *Rupel*, 14 Ind. 209.

§ *Westover* vs. *Ætna Life Ins. Co.*, 99 N. Y. 56; *Loder* vs. *Whelpley*, 111 N. Y. 239;

consequently, in an action against a life insurance company on a policy, the defendant cannot prove by an attending physician the condition of health of decedent or members of his family prior to his application,* nor in an action by an executor against the company where the defense is the insured's suicide can the plaintiff show by decedent's physician that the insured was insane.† A waiver need not be in writing or made in any particular form or manner. The circumstances may show an express intent to make it; as if a testator ask his physician or attorney to subscribe his will as a witness; where the request necessarily implies that the witnesses are at liberty to testify as to the circumstances surrounding the execution of the will and the testator's mental condition; or there may be an agreement before death, as in an insurance policy, that the physicians attending the insured at his decease may testify as to the cause of death.‡ But where there is no such contract, is a certificate of the attending physician, filed with the proofs of death as to the cause of the insured's demise, competent evidence? It has been said already that the physician's direct testimony on that point is not admissible; but his certificate may be admitted upon grounds that commend themselves more to the legal than to the lay mind. To illustrate, A, who is insured under a policy avoided by drunkenness, dies. B, the beneficiary, gets from the company a blank form of proof of death, including a request for a statement of the cause of death, to which information the company is not entitled. A's physician violates professional confidence and gives a certificate erroneously stating that A died of delirium tremens. B offers proof of some more respectable illness. The certificate is admissible in evidence not as original proof of the cause of death, but as an admission by the plaintiff against his interest. But if the beneficiary of the policy be an infant ward, such an admission by his guardian does not bind him, and is therefore incompetent evidence.§

During the lifetime of a plaintiff, his attorney, on the trial of his action to recover damages for injuries, may waive his privilege and call his physicians to testify to his physical condition, notwithstanding defendant's objection.‖ It has been said that the mere bringing of an action to recover damages for personal injury does not constitute a waiver of the plaintiff's privilege that will allow defendant to call the latter's physicians to testify as to his condition.¶ Nor does a plaintiff by suing for

Penn. Mut. Life Ins. Co. vs. *Wiler*, 100 Ind. 92. In Indiana it would seem that a decedent's physician may not testify against his patient's competency to make a will: *Heuston* vs. *Simpson*, 115 Ind. 62. But he may be called by decedent's executor or other successor in interest to uphold the will even although the widow object and invoke decedent's privilege: *Morris* vs. *Morris*, 119 Ind. 341; cf. *Masonic Ass'n* vs. *Beck*, 77 Ind. 203. The rule in Missouri is similar: *Thompson* vs. *Ish*, 99 Mo. 160; and so in Michigan: *Fraser* vs. *Jennison*, 42 Mich. 206, where Judge Cooley said what the patient "may do in his lifetime, those who represent him after his death may do for the protection of the interests they claim under him." But see *Dreier* vs. *Continental Life Ins. Co.*, 24 Fed. 670.

* *Grattan* vs. *Metropolitan Life Ins. Co.*, 80 N. Y. 281; *Breisenmeister* vs. *Supr. Lodge Knights of Pythias*, 81 Mich. 525. But he may testify to having attended decedent or his family: *Breisenmeister* vs. *K. of P.*; *Numrich* vs. *Lodge &c.*, 3 N.Y. Supl. 552.

† *Westover* vs. *Ætna Life Ins. Co.*, 99 N. Y. 56.

‡ Matter of Coleman, 111 N. Y. 220; *Alberti* vs. *N. Y. L. E. & W. R. R. Co.*, 118 N. Y. 77; *Andreveno* vs. *Mutual Reserve &c. Ass'n*, 34 Fed. 870.

§ *Buffalo Loan &c. Co.* vs. *Knights Templars &c. Ass'n*, 126 N.Y. 450; 27 N. E. 942; cf. *Dreier* vs. *Continental Life Ins. Co.*, 24 Fed. 670; *Helwig* vs. *Mut. L. Ins. Co.* 132 N.Y. 331.

‖ *Alberti* vs. *N. Y. L. E. & W. R. R. Co.*, 118 N. Y. 77.

¶ *Jones* vs. *Brooklyn B. & W. E. R. R. Co.*, 3 N. Y. Supl. 253; afd. 121 N. Y. 683.

injuries resulting from miscarriage waive her privilege so as to admit testimony of physicians who attended her some months before her accident but not after it.* In New York, Missouri, and Michigan it is held that if plaintiff call one of several physicians to testify to his bodily condition resulting from injuries, he does not waive the privilege as to the others.† And in Iowa, where a plaintiff testified in her own behalf that her health had always been good prior to the accident whereby she sustained the damages which she sued for, this was held to be no such waiver as would permit the defense to call physicians who had attended her to contradict her testimony.‡ So in Indiana, it was held that plaintiff's testimony that a certain physician had treated her injuries was not a waiver permitting him to be called.§ In a comparatively recent case a plaintiff, having testified that he had called several times on a physician who asked him no questions, gave him no advice, but merely examined his eye and told him, on the third visit, "to get examined by a doctor," it was held that although these facts constituted the relation of physician and patient, nevertheless the plaintiff's testimony waived his privilege and made it error to exclude the physician's testimony. The court said: "Can it be that a patient can distort the features of a consultation with his physician so as to do the physician the greatest of injury, and the physician be prohibited from defending himself? Clearly not. The patient may keep the door of the consultation-room closed, but he cannot be permitted to open it so as to give an imperfect and erroneous view of what has taken place there, and then close the door when the actual facts are about to be disclosed. This would be allowing a plaintiff to manufacture evidence for himself in cases of this description, and prevent the defendant from resorting to the only means to elicit the truth."‖ And in a still more recent case in the New York Common Pleas, where a plaintiff testified fully as to her injuries, the General Term of that court, adopting the language above quoted, held her testimony to be a waiver making her physician a competent witness against her.¶ It may be noted that in both of these cases the physician was called not to testify to the existence of any ailment of the patient, but, on the contrary, to the patient's freedom from the specific injury or disease in issue. And it had been suggested previously by the Court of Appeals that the object of the statute being to prevent the disclosure of the patient's ailments, it was questionable whether testimony that the patient was in good health could be regarded as prohibited.** In the former of these two cases, that of Marx, it may be said that plaintiff having testified to certain conduct of a physician, it was competent to call the latter, because the patient had opened the door for his entrance into the case; but it is hard to see

* *Butler* vs. *Man. Ry. Co.*, 23 N. Y. Supl. 163; 30 Ab. N. C. 78, see note.

† *Hope* vs. *Troy & L. R. R.*, 40 Hun, 438; 110 N. Y. 643; followed in *Mellor* vs. *Missouri Pac. Ry. Co.*, 105 Mo. 455; 16 S. W. 866; *Dotton* vs. *Village of Albion*, 57 Mich. 575; 24 N. W. 786.

‡ *McConnell* vs. *City of Osage*, 80 Iowa, 293; 45 N. W. 550; *semble* if she testified to a statement made to the physician he might contradict her as to that.

§ *Williams* vs. *Johnson*, 13 N. E. 872.

‖ *Marx* vs. *Man. Ry. Co.*, 56 Hun, 575 (May, 1890). This is consonant with the common law rule that if a client testify against an attorney, the latter may protect himself by testifying to a privileged communication.

¶ *Treanor* vs. *Man. Ry. Co.*, 16 N.Y. Supl. 536; 28 Ab. N. C. 47; cf. *Freel* vs. *Market St. Cable Ry. Co.*, 31 Pac. 730.

** *People* vs. *Schuyler*, 106 N. Y. 298.

how, even by most subtle reasoning, the Treanor case can be brought into accord with *Record* vs. *Village of Saratoga Springs** and *Hope* vs. *Railroad*.† Marx, by testifying that a physician examined him thrice and told him nothing, except to go to another physician for examination, and Treanor, by testimony as to the injury of her head, are held to have waived the privilege so as to permit their physicians to contradict them and show that they had little or nothing the matter. While Hope and Record each testified in detail as to their respective injuries, and each called one of the attending physicians in corroboration, and yet neither was held to have waived by this testimony the privilege as to other attending physicians. The question, although substantially the same in all actions to recover damages for negligence, has always seemed clearer when the action grows out of alleged medical malpractice; for here the nature of disease or injury and all circumstances necessary to judge of the skill and wisdom of defendant's treatment are the main issues, and the plaintiff waives the privilege both as to the attending physician and his consultants.‡

But when it is the question whether if a party to an action offers upon one trial medical testimony as to his physical condition this is such a waiver of privilege as will permit the other party on a new trial to offer the same testimony, we again find doubt and conflicting decisions. The New York Court of Appeals have decided this point upon reasoning that, at least, as the phrase is, "squints both ways." In Grattan's case,§ upon a second trial the defense called a physician who attended the insured in his last illness. The witness had testified on the former trial, but it did not appear by whom he was then called. He was asked if he had not then testified in reply to plaintiff's counsel that the insured died of consumption. This was held to be improper: first, because what he testified at the former trial was admissible only to refresh his memory or discredit him, and the occasion for doing either did not exist; second, because the court did not agree that the plaintiff's inquiry on the former trial precluded his objection on the latter one. "It was an incident in the mode of trial. It waived for that occasion and under then existing circumstances an objection which might have been relied on. It was in no sense an admission of the party, but proof by a witness. The party was not even then bound by the fact, but might disprove it." If this language could be understood as a rule that a waiver on one trial is not a waiver for all time—and the Michigan Supreme Court has so understood it‖—then the case is distinctly overruled by that of McKinney,¶ where it is argued that after the patient had once admitted his confidence to be published, the purpose of the statute, viz.,

* 46 Hun, 448; afd. 120 N. Y. 646; cf. *McConnell* vs. *City of Osage*, 80 Iowa, 293.

† 40 Hun, 438; cf. with this and the Treanor case, the opinion in *Jones* vs. *Brooklyn B. & W. E. R. R. Co.*, 3 N. Y. Supl. 253; afd. 121 N. Y. 683.

‡ *Lane* vs. *Boicourt*, 27 N. E. 1111 Ind.

§ *Grattan* vs. *Metropolitan Life Ins. Co.*, 92 N. Y. 275.

‖ *Breisenmeister* vs. *Knights of Pythias*, 81 Mich. 525.

¶ *McKinney* vs. *Grand St. &c. Ry. Co.*, 104 N. Y. 352. The reasoning of this case has been cited lately in a Nevada case, *State* vs. *Depoister*, 25 Pac. 1000, where an objection by defendant, charged with rape on a child of seven years, to admitting testimony of the infant's physician, was held to be untenable on the ground that the child's parents, by testifying as to the facts, had both impliedly waived the privilege and, by giving publicity to the matter, removed the ground of the privilege.

to protect him, was defeated, and upon the principle, "*Cessante ratione legis cessat ipsa lex*," the privilege could never again be claimed. With this argument the Michigan Supreme Court does not agree, but holds in the Breisenmeister case that the object of the statute being to enable the patient to control the evidence, as well as to suppress the information, a waiver on one trial is not a waiver thereafter, thereby following what they assume to be the rule in Grattan's case (*supra*); but there is, however, this vital point in Grattan's case clearly differentiating it from McKinney's, namely, that in the former the privilege was that of the insured; and he being dead, no one under the rule in Westover's case (*supra*) could waive it.*

It is unnecessary further to discuss the cases. Ever since the common law rule was abrogated by statutes, two conflicting tendencies have been at work in construing the law: the one to confine privilege to the narrowest limits within which its assumed purpose could be effectuated, as though the statute were in derogation of a common right;† the other to construe the law liberally according to its plain language as a remedial statute, leaving it for the legislature to modify its terms if necessary.‡ And whether or not invariable adherence to the latter principle would have worked greater injustice in individual cases, it would have effected probably greater certainty in the law, which is no small boon. The statute is plain in its terms. If it works injustice in testamentary, insurance, negligence, or criminal cases "the remedy is with the legislature, and not with the courts."§ And this remedy has already been essayed in New York, where the privilege originated and has been most stoutly fought over. (See note at the close of this title.) It is to be remarked also that in general the statutes creating this privilege only provide that the physician "shall not be allowed to disclose" this privileged information. But under the decisions and the practice this prohibition is in many instances mere *brutum fulmen*—"sound and fury, signifying nothing." Who is it that is not to allow this gross breach of faith? Apparently not the court; for it is said that the rule does not go "further than to stamp such communications as confidential, and to protect them from disclosure, *when objected to;* unless the privilege has been competently waived. The rule does not prohibit the examination of such classes of witness; but it prohibits the evidence of the character described from being given *in the face of an objection*."‖ This word "objection" being injected into the statute, it would seem that, notwithstanding the so-called privilege of the dead, still if in a probate contention a greedy crowd on both sides are scrambling for decedent's gold, all willing to bemire his name for gain, and none having an interest to protect his memory, the court is to sit quietly in the absence of objection, and allow a physician to betray the trust reposed in him. "If," said the court in a case cited heretofore, "a physician, disregarding the plain obligations of his situation, should, in conversation, disclose the

* 99 N. Y. 56.

† *Edington* vs. *Ætna Life Ins. Co.*, 77 N. Y. 564.

‡ *Edington* vs. *Mutual Life Ins. Co.*, 67 N. Y. 185.

§ *Renihan* vs. *Dennin*, 103 N. Y. 573. In Missouri a defendant devisee may waive decedent's privilege and call his physician: *Thompson* vs. *Ish*, 99 Mo. 160. So in Indiana, if the testator's legal representative call decedent's physician, the latter may testify to decedent's sanity: *Morris* vs. *Morris*, 21 N. E. 918; 119 Ind. 341.

‖ *Hoyt* vs. *Hoyt*, 112 N. Y. at p. 515.

secrets of his patient, he would, so far as we know, violate no statute, however reprehensible his conduct would be,"* and therefore such revelations, though incompetent as original evidence *if objected to*, may be received indirectly, if repeated by a party as his admissions if adverse to his interest. And thus it happens that the mantle which the law intended to throw over the confidences of physician and patient is constantly torn away by the hand of vulgar greed, because instead of absolutely prohibiting the disclosure or its repetition, some unspecified power, ostensibly the court, but, as it would seem, the court only as the medium of an objector, is commanded not to allow it.† But in this maze of argument there is nothing to puzzle the physician or surgeon. As to him, the rule is clear and his duty plain. He is to regard all knowledge concerning his patients' affairs as sacred, and to refuse to testify concerning it except at the request of the patient or under the direct order of the court; and even when commanded to testify from the bench, he should feel his way cautiously and not meet the examiner with indecent haste. For the guidance of the lawyer the rule seems to be that all information acquired by a physician through any of his senses in his professional relation with a patient, or one having valid reason to believe himself a patient, is privileged if it in any way conduces or was intended to conduce to his knowledge, or aid his treatment of the case; whether

* *Buffalo Loan & T. Co.* vs. *Knights T. &c. Ass'n*, 126 N. Y. at p. 455; cf. *Sullings* vs. *Shakespeare*, 46 Mich. 408; 41 Am. R. 166. Such a breach of confidence, however, is clearly a wrong, and is analogous to the betrayal of confidence by a physician who takes a layman unnecessarily to a case of labor, for which wrong substantial damages have been recovered. (See end of this title.) Nor is judicial authority lacking to maintain that a judge, or even a commissioner, who is but a machine to take depositions, should exclude such testimony. Thus in *Storrs* vs. *Scougale*, 48 Mich. 387, a physician having testified before a commissioner that his patient had an offensive disease, Mr. Justice Cooley said: "This evidence ought not to be passed over without remark. . . . The physician had no business to give it. . . . If a physician is found disposed to violate both the law of the land and the precepts of professional ethics by making such a disclosure, and if counsel invite him to do so by their questions, the commissioner, in the case of so plain a disregard of the law to the prejudice of a third party, may well decline to be an instrument of the wrong; at least until he can take the opinion of the circuit judge on the subject. . . . It is to be regretted that the circuit judge did not have his attention directed to this evidence, for he would probably have ordered it stricken out at the cost of the party taking it. He would have needed to wait for no motion for that order." In matter of Hannah, 11 *N. Y. St. R.* 807, the court said the physician's testimony should never have been received, and the privilege should have been asserted. Cf. *Linz* vs. *Mass. Mut. Ins. Co.*, 8 Mo. Ap. 363.

† Since the decisions were rendered in these cases of *Hoyt* vs. *Hoyt* and *Trust Co.* vs. *Knights Templars*, the New York Code has been amended in 1877, 1891, 1892, and 1893, so that as this book goes to press the sections relating to this privilege read as follows:

"§ 834. A person duly authorized to practice physic or surgery shall not be allowed to disclose any information which he acquired in attending a patient in a professional capacity, and which was necessary to enable him to act in that capacity.

"§ 836. The last three sections apply to any examination of a person as a witness unless the provisions thereof are expressly waived upon the trial or examination by the person confessing, the patient or the client. But a physician or surgeon may upon a trial or examination disclose any information as to the mental or physical condition of a patient who is diseased, which he acquired in attending such patients professionally, except confidential communications and such facts as would tend to disgrace the memory of the patient, when the provisions of § 834 have been expressly waived on such trial or examination by the personal representatives of the deceased patient, or if the validity of the last will and testament of such deceased patient is in

it be the result of his own observation or be imparted to him because of his professional relation to the patient. Only the patient can waive the privilege, which is perpetual, unless the statute expressly or by judicial construction provide otherwise, but nevertheless to insure the exclusion of the disclosure an objection is necessary; and if in default of such objection such a disclosure be made, it will be considered on appeal. Nevertheless, as "the evidence is in itself objectionable,"* it would seem to be the clear duty of the court, certainly in all cases where a question calls for the disclosure of a privileged communication made by one not a party to the litigation, to effect the purpose of the statute by protecting those who are dead, or for any reason not present or competent to protect themselves or their memory from reproach.

Sanctity of the Person.—Analogous to the duty of guarding professional confidences is that of protecting the sanctity of the patient's person. A patient cannot be made a subject of clinical study or impertinent curiosity against his will. And the pudicity of a woman is particularly to be regarded. A country physician took an unmarried layman to carry his lantern and umbrella to a confinement case. There was but one room in the woman's house, and there the doctor took his friend. There being no real need of the layman's presence to assist in the case, this action was considered to be in the nature of trespass, rendering both the physician and his friend liable in substantial damages to the woman and her husband for this wanton invasion of their privacy.†

Although it is said that there is no property in a dead body,‡ so that a man cannot dispose of his remains by will,§ or enforce a contract for the sale of a corpse,‖ or replevin his amputated leg if the surgeon walks off with it, nevertheless the desecration of the graves and bodies of the dead is an offense to public decency, punishable at common law as a

question, by the executor or executors named in said will, or the surviving husband, widow, or any heir-at-law, or any of the next of kin of such deceased, or any other party in interest. But nothing herein contained shall be construed to disqualify an attorney in the probate of a will heretofore executed or offered for probate, or hereafter to be executed or offered for probate, from becoming a witness as to its preparation and execution in case such attorney is one of the subscribing witnesses thereto. In an action for the recovery of damages for a personal injury the testimony of a physician or surgeon attached to any hospital, dispensary, or other charitable institution as to information which he acquired in attending a patient in a professional capacity, at such hospital, dispensary, or other charitable institution, shall be taken before a referee appointed by a judge of the court in which such action is pending; provided, however, that any judge of such court at any time in his discretion may, notwithstanding such deposition, order that a subpœna issue for the attendance and examination of such physician or surgeon, upon the trial of the action. In such a case a copy of the order shall be served, together with the subpœna.

"Sections 872, 873, 874, 875, 876, 879, 880, 884, and 886 of this code apply to the examination of a physician or surgeon as prescribed in this section." The word "diseased" in Section 836 is an inadvertence. The word has been deceased until the passage of c. 295, Laws of 1893, when the mistake was made. By these amendments the power of waiver has been enlarged. What their effect will be the learned Dr. Abbott has essayed to outline (see notes to *Abbott's New Cases*, vol. xxviii. at p. 55. and vol. xxx. at p. 84, also *Columbia Law Times*, April, 1892); but who shall blithely assume to prophesy the result of legal hermeneutics when applied by different courts?

* *Westover* vs. *Ætna Co.*, 99 N. Y. at p. 60.

† *De May* vs. *Roberts*, 46 Mich. 160; 41 Am. R. 154.

‡ Blackstone Com. 2, 429; Corven's case, 12 Co. 105; Haynes's case, *ib.* 113; 3 Inst. 202; *R.* vs. *Lynn*, 2 T. R. 733.

§ *Williams* vs. *Williams*, L. R. 20 Ch. D. 659. He may under special statutes; § 305 Penal Code of New York so provides.

‖ *Am. Law Times*, July, 1871.

misdemeanor;* a civil action will also lie for the trespass on the soil, and the circumstances of the act may be shown to enhance damages.† When the body is once buried, it cannot be removed without the consent of the owner of the grave, or permission of the proper ecclesiastical, municipal, or judicial authority.‡ This topic, which is more curious than practical, is more fully discussed in Wilcock's *Medical Profession*,§ and the treatise of Mr. Rogers.‖ Its practical bearing is upon the method of procuring material for the dissecting-room. By an early statute "to prevent the odious practice of digging up and removing, for the purpose of dissection, dead bodies interred in cemeteries or burial places,"¶ the New York legislature provided that in the exercise of their discretion the judges of the Supreme Court, oyer and terminer or goal delivery, might make it part of the sentence of one convicted of murder, arson, burglary, or any capital crime, that his body should be delivered to a surgeon for dissection; and since this act was passed provision has been made by law, in New York and elsewhere, both to furnish to the hospitals and schools the bodies of convicts and other unclaimed dead for dissecting-material, and also to punish body-stealing, grave-desecration, and unlawful dissection.** In a very extraordinary case of late years, a woman, at whose request a coroner had exhumed the remains of one deceased, was convicted of body-stealing, but the judgment was reversed on appeal.†† And a father who exhumed his child's body to get its thigh-bone as an exhibit in an action for malpractice was held not to have violated the statute.‡‡

Duty as to Contagious Diseases.—A duty is devolved upon practicing physicians in most jurisdictions of reporting to the municipal authorities the existence of diseases classified as contagious, an omission to perform which subjects the delinquent to a penalty. Such sanitary regulations are different in different States, are subject to constant change by amendment, and must be sought not only in the statute books but in the sanitary codes issued by Boards of Health. The duty to report a case of contagious disease is of course directly in conflict with the physician's duty to guard the secrets of the sick-room; but it grows out of the fundamental principle, *Salus populi suprema lex*. At the same time it may well be questioned how far a statute imposing this duty could be effectually enforced, if, with a view to quarantining them, the classification of contagious diseases should be enlarged to include, as is now suggested, consumption and tuberculous maladies.

It is, of course, the physician's duty to use every precaution when attending a contagious disease to avoid becoming himself a medium of

* *R.* vs. *Lynn*, 2 T. R. 733.

† *Meagher* vs. *Driscoll*, 99 Mass. 281.

‡ *Weld* vs. *Walker*, 130 Mass. 422; cf. *R.* vs. *Sharpe*, 7 Cox C. C., where defendant was convicted of misdemeanor in removing his mother's body to bury it by his father's; *Wynkoop* vs. *Wynkoop*, 42 Penn. St. 293; *Guthrie* vs. *Weaver*, 1 Mo. Ap. 136; *contra*, *Bogert* vs. *Indianapolis*, 13 Ind. 134.

§ London, 1830.

‖ *The Law and Medical Men*, by R. Vashon Rogers, Jr., Toronto, 1884.

¶ Laws of 1789, c. 3.

** Penal Code of New York, §§ 305 to 314 inclusive; ch. 123, Laws of 1854 as amended by Laws of 1887; Rev. Statutes, 8th ed., vol. ii, p. 1219 & Part IV. ch. 3; Art IV., §§ 132, 133, vol. iv., p. 2821. (See the statute books of other States.)

†† *People* vs. *Fitzgerald*, 105 N. Y. 146. In New York the district attorney may exhume a body for examination: Penal Code, § 308.

‡‡ *Rhodes* vs. *Brandt*, 21 Hun, 1.

infection; and where a physician, contrary to his promise to one patient, attended another one sick with smallpox, and communicated the latter's disease to the former, it was held that he was liable for the results of his negligence, and that they might be shown in reduction of his charges.* If it be necessary, a physician may order, under the Maine law, proper disinfecting process even to the extent of destroying property; for instance, causing the removal of wall-paper of an infected room;† and it was held to be an indictable offense unlawfully to inoculate children with smallpox,‡ or while they were sick expose them in the public highway.§ Under a Michigan statute requiring physicians to report immediately contagious diseases, it was held a question for the jury whether a physician, who had reported cases of diphtheria in children a week or ten days after his diagnosis, had acted within a reasonable time; and it was decided that diphtheria, being a virulent and rapid disease, eight days was not a reasonable time, and also that verbal mention to the health officer of the existence of the cases was not such a report as the statute required.|| The question of the liability of a physician to a patient for reporting him as sick of a contagious disease was considered a few years ago in a New York case that aroused much interest at the time. Dr. Purdy, a physician of excellent professional standing, who had been elected president of the medical society of that county, was called in by a Miss Brown, a florist, to attend her. The testimony was conflicting. The patient at the time of her illness was suffering from a cutaneous affection, and expert testimony differed as to whether it was a light attack of smallpox or only an eczema. However that matter be, the physician considered the case one of smallpox, and called in a health inspector, who agreed with that diagnosis and ordered the removal of the patient to the smallpox hospital, whence she was soon after discharged. In an action against Dr. Purdy, Miss Brown recovered a verdict of five thousand dollars; but upon appeal this judgment was reversed upon the ground that her removal was an independent act of the inspector upon his own diagnosis; that Dr. Purdy was only performing his duty in making his report, whether he was mistaken or not, and that the complaint should have been dismissed.¶ The principle of the Purdy case is equally applicable in cases of "Commitment of the Insane," although no duty of reporting the condition of an insane patient to the public authorities is prescribed, as in the case of contagious diseases. Whether such a report should not be required in all cases where the patient's mania is of homicidal tendency is worth serious consideration. The liability of physicians upon whose reports persons are committed as insane has been carefully considered.** And it has been held that while the judge who signs the report possesses judicial immunity, the physicians who make

* *Piper* vs. *Menifee*, 12 B. Monroe (Ky.) 465.

† *Seavy* vs. *Preble*, 64 Me. 120; cf. *Raymond* vs. *Fish*, 51 Conn. 80; a case of destroying oyster beds in purifying a river.

‡ *R.* vs. *Burnett*, 4 M. & S. 272.

§ *R.* vs. *Vantandillo*, 4 M. & S. 73.

|| *People* vs. *Brady*, 90 Mich. 459; 51 N. W. 537.

¶ *Brown* vs. *Purdy*, 54 Super. Ct. (N.Y.) 109; 8 N.Y. St. R. 143, cf. *Pennell* vs. *Cummings*, 75 Me. 163. If patients are carelessly removed the authorities are liable: *Aaron* vs. *Broiles et al*, 64 Tex. 316.

** *Ayers* vs. *Russell*, 50 Hun, 282; *Pennell* vs. *Cummings*, 75 Me. 163; *Hall* vs. *Semple*, 3 F. & F. 337.

it act as medical experts, not as judicial officers, and are liable, as in other cases of malpractice, for their failure to have and exercise due care, skill, and knowledge. They must make careful examination of the facts in the case. There are few graver wrongs than the careless commitment of a sane person to a lunatic asylum. And where an eminent alienist directed a commitment upon hearsay alone this was admitted by counsel of both parties to be assault, and a verdict of five hundred pounds was rendered against the physician.* A somewhat analogous case of wrong-doing by the erroneous report of a physician occurred in New York, where a verdict for plaintiff was sustained in an action for deceit growing out of the fact that defendant, the surgeon of the Seventh Regiment of New York, had made a maliciously false report of plaintiff's physical condition, thereby causing the latter to be discharged from the regiment.†

Partnership.—The ordinary mercantile partnership is an association of two or more persons to carry on a particular business and share its profits and losses. And within the scope of this business they are liable one for the act of the other. In an early New York case partners in the practice of physic were said to be, within the law merchant.‡ And in Tennessee the note of one of two physicians in partnership was said to be binding on both if "executed for anything for which a firm of physicians had use"; e.g., drugs or instruments, even though the proceeds were appropriated to his own use by the drawer. "But," continued the court, "money is not an article for which such a firm has use directly, though it may indirectly." And therefore, the drawing of notes not being within the scope of the partnership, the firm is not bound.§ The "good-will" of a medical practice may be sold, and it is a valid agreement if the seller contract not to practice in a certain locality.|| Mr. Glenn says that a medical man is liable for wrongful acts of his partner in practice,¶ and there are two American cases that so hold.** In *Hyrne* vs. *Erwin* it appeared that a father and son practiced medicine as partners, and both were charged with negligence in practice. Plaintiff recovered a verdict. The court said that in such an association each partner "guarantees that within the scope of the common business reasonable care, diligence, and skill shall be displayed by the one in charge," or at least the failure of one to exercise such skill and care is the failure of all. In *Whittaker* vs. *Collins* it appeared that plaintiff had employed the firm of Graff & Collins to set his leg, which was broken. Graff attended him part of the time skillfully, so plaintiff considered, but Collins attended him the rest of the time, and made a mess of it. So Whittaker, holding Graff blameless, considerately sued Collins, alone; but the defendant ungraciously demurred to the complaint on the ground of defect of parties; and the court considering the action to be in contract, sustained the demurrer because the innocent Graff was not sued. This

* *Anderson* vs. *Burrows*, 4 C. & P. 210.

† *Dederick* vs. *Morris*, 14 Week. Dig. 232.

‡ *Allen* vs. *Blanchard*, 9 Cow. 631.

§ *Crosthwaite* vs. *Ross*, 1 Humph. 23; cf. *Thompson* vs. *Howard*, 2 Ind. 245.

|| *Hoyt* vs. *Holly*, 39 Conn. 326; *Dwight* vs. *Hamilton*, 113 Mass. 175; *Warfield* vs. *Booth*, 33 Md. 63; and see *May* vs. *Thompson*, L. R. 20 Ch. D. 705; *Christie Administratrix* vs. *Clark*, 16 Upper Canada C. P. 544.

¶ *Manual of the Laws Affecting Medical Men* (London, 1871), at p. 340.

** *Hyrne* vs. *Erwin*, 23 S. C. 226; 55 Am. R. 15; *Whittaker* vs. *Collins*, 34 Minn. 299; 25 N. W. 632.

shows the danger of partnerships, and recalls the occasion when Chang, the Siamese twin, having been made president of a total abstinence society and chosen to lead its parade, Eng fuddled himself, and the two stoned the procession to the lasting disgrace of Chang, who never used stimulants.

An unlicensed person may form a partnership with a qualified practitioner, and share the profits of the practice, although he cannot himself treat the patients of the firm.* And whatever the conditions of the relationship may be, its liabilities are dependent on its scope and the application to it of the general principles of partnership.

Grateful Patients, as is well known, often send gifts to their doctors. Sometimes the gift is in lieu of payment of the bill, but often it is given by way of bequest, and is of considerable value. If it be a large part of decedent's estate, the question of undue influence might be raised. It is enough to say on this point that while a medical man may make a contract with or be the legatee of his patient, still if the donor or testator be a person of weak mind the relation is such as to make the court view the transaction with suspicion. Nor should a physician who has reason to believe that he may be a legatee sign a will as witness, lest being called on to prove the document he lose his legacy. The cases on undue influence are, as Mr. Redfield says, "almost infinite in number and variety," and it is impossible in a limited space to do more than refer to a few in which the relation of physician and patient has played part.†

Who Owns the Prescription? is a question frequently asked by physicians, but not as yet answered by the courts. In his treatise on medical jurisprudence Ordronaux has devoted some pages to its discussion; but the matter is one of academic rather than of practical interest. The patient pays for advice. He receives a prescription orally or in writing. It is his. He can take it as often as he wishes at his own risk, or give it to his friends. No one has ever pretended that a lawyer can forbid a client repeating the legal advice given to him. Perhaps a contract might be made with the patient not to "repeat the prescription"; but then if he break the agreement, what is the physician's measure of damages? If indeed the patient put up the prescription as a patent medicine and advertise it under the physician's name, this might be a libel;‡ but the gist of that offense would be not selling the prescription, but imputing unprofessional conduct. There is no practical method of preventing a patient from repeatedly swallowing a prescription intended for a single occasion, except to give him the actual remedy, after the old fashion, now again coming into vogue, or else to make the dose so disagreeable that to take it will be a pain rather than a pleasure.

Criminal Offenses.—It has been seen that the practice of medicine in some jurisdictions is entirely free; in others it is prohibited to the unlicensed under penalties collectable in civil suits; in yet others unlawful practice is declared to be a misdemeanor. In any criminal prosecution or suit for penalty against an unlicensed practitioner, the plaintiff's

* *Turner* vs. *Reynall*, 14 C. B. N. S. 328; 8 L. T. 281.

† *Crispell* vs. *Dubois*, 4 Barb. 393; *Dent* vs. *Bennett*, 4 Myl. & C. 269; *Gibson* vs. *Russell*, 2 Y. & Coll. C. C. 104; *Popham* vs. *Brooke*, 5 Russ. 8; *Greville* vs. *Tylee*, 7 Moo. P. C. 320; *Calhoun* vs. *Jones*, 2 Redf. 34; *Peck* vs. *Belden*, 6 Dem. 289; cf. *Newhouse* vs. *Godwin*, 17 Barb. 236, where an attorney was legatee. The English cases are collected in Glenn's *Manual*, p. 312 seq.

‡ *Clark* vs. *Freeman*, 11 Beav. 112.

prima facie case is made out as soon as defendant's practice is shown.* The burden of proving authority then shifts to defendant.† Nor is this making the accused prove his innocence, as some have fancied. The forbidden act is the practice, and the defense is a license, which must be established affirmatively like the defenses of *autrefois acquit* and former jeopardy. Were this not the rule, it would be obviously impossible to convict unlicensed practitioners in jurisdictions where any medical diploma is a license; for the prosecution would have to prove a negative as wide as the world.

Proof of Diploma.—In order to establish his defense, the defendant must show the qualifications required by the statute; and if one of them be the possession of a diploma conferred by a foreign corporation, it is not enough to produce the parchment, but under the strict rule he should prove also the charter of the college, its existence at the date of the diploma, the genuineness of the seal, and that it was affixed by the proper officer;‡ but in practice the rigor of the rule is relaxed. It would seem, too, that compliance with the requirements preliminary to conferring the degree should also be shown.§

It scarcely needs a statute to emphasize the inadvisability of undertaking any duty with "a drappie in our ee"; but it has seemed good to legislative wisdom in several States ‖ to declare the performance by an intoxicated physician or surgeon of any act endangering the patient's life, or seriously affecting his health, a misdemeanor, or if death result, manslaughter.¶ And under the common law Baron Garrow, in Long's case,** said: "Suppose the person comes drunk, and gives me a tumblerful of laudanum, and sends me into the other world, is it not manslaughter?" Bayley considered, however, that so rash an act would be homicide, whether the prescriber were tipsy or sober;†† but in the Georgia case referred to (*supra*) it was held no good plea in defense to Dr. Sewell's suit against Mr. McKleroy for fees, that plaintiff went to defendant's house in a state of intoxication, and administered four cups of ipecac at a dose, which caused him to vomit so violently that he was

* As to what constitutes practice, see *ante*.

† *Apothecaries Co.* vs. *Bentley*, 1 C. & P. 538; *People* vs. *Nyce*, 34 Hun, 298; *People* vs. *Fulda*, 52 Hun, 65; *People* vs. *Rontey*, 4 N.Y. Supl. 235; 117 N.Y. 624; *Raynor* vs. *State*, 62 Wis. 289; 22 N. W. 430; Wharton on *Criminal Evidence*, §§ 333–341; Lawson's *Presumption of Evidence*, p. 20.

‡ *Hill* vs. *Boddie*, 2 Stew. & Porter (Ala.), 56; *Hunter* vs. *Blount*, 27 Ga. 76; *Moises* vs. *Thornton*, 8 T. R. 303; but see *Finch* vs. *Gridley's Excrs.*, 25 Wend. 469; and *Walmisley* vs. *Abbott*, 1 C. & P. 309.

§ *Andrews* vs. *Styrap*, 26 L. T. R. 704; *Chadwick* vs. *Bunning*, 2 C. & P. 106; and *Collins* vs. *Carnegie*, 1 A. & E. 695.

‖ N. Y. Penal Code, § 357; Rev. Stat. Ohio, § 6813; Gen. Stats. Mich., § 9319; and see statute books of other States. There seems to be no need for such a statutory regulation of the drinking habits of lawyers; whether on account of their capacity or their good habits may be surmised.

¶ Penal Code, § 200.

** *Rex* vs. *St. John Long*, 4 C. & P. 378.

†† *Rex* vs. *St. John Long*, 4 C. & P. 423. Whether causing the death of a patient by erroneous medical treatment would be manslaughter on the part of the unlicensed physician, although only actionable malpractice on the part of a legally qualified practitioner, is more appropriately discussed under Malpractice. It is sufficient here to say that whether a practitioner be licensed or not, if by his gross ignorance or negligence he causes the patient's death, he may be guilty of manslaughter. (See the opinion of Judge Oliver Wendell Holmes, Jr., in the recent case (1884) of *Pierce* vs. *Commonwealth*, 138 Mass. 165, 52 Am. R. 264.) It is a principle of common law, how-

seriously injured, and was damaged to the extent of two hundred dollars. For the court held that "tort cannot be set off against contract," and added: "The idea that an overdose of ipecac endangered a man's life two hundred dollars, without stating in the plea wherein and how, is hardly plainly and distinctly setting out a defense." *

Abortion.—The unlawful attempt to kill a child *en ventre de sa mere* has been said to be only a misdemeanor at common law; but if the death of an unborn child, or of the mother, result from the attempt, this will render the defendant guilty of homicide. The degree of the crime is now established by statute in nearly every civilized jurisdiction; the ill-founded distinction between the condition of the child before and after quickening being generally maintained. Of course to save the mother's life procuring an abortion is lawful, but the burden of proving the necessity of the operation is upon the defendant.† The full discussion of this topic also is referable to the article on Malpractice.

To have carnal knowledge of a patient under pretense of medical treatment,‡ or to unnecessarily make her disrobe under pretext of examination,§ have been held to be assaults. In *Regina* vs. *Case*, it appeared that defendant, a surgeon, under pretense of treating a girl fourteen years old for suppressed menstruation had had carnal intercourse with her, she consenting in the belief that it was good treatment. And Wilde, C.-J., discussing the evidence in the case, said: "The defendant, for aught that appears to the contrary, may have adopted the course he took *bona fide* with a view to her cure. The court cannot say that it might not have been beneficial in a medical point of view." But in the end the entire court agreed that such a system of practice should be discouraged, and affirmed the conviction.

Excise Laws are not to be disregarded by the medical practitioner, who must be wary in prescribing *spiritus frumenti*, especially if the patient is a chronic sufferer and given to repeating the prescription. In Alabama, where a physician may lawfully administer the prohibited liquor in cases of necessity, he cannot prescribe a quart of whiskey and give the patient an order for it upon a drug shop in which he is interested.|| And if a country doctor prescribe and furnish whiskey at the usual price he is a retailer, and violates Section 3242 of the Revised Statutes of the United States, unless he pay the special tax.¶ In Iowa a doctor cannot without a permit put up prescriptions containing intoxi-

ever, that if one, while committing a misdemeanor, cause death, he is guilty of manslaughter; and, as we have pointed out, illegal practice of medicine in England is a prohibited offense punishable only by a civil penalty, and not an indictable misdemeanor. This was true in the time of Hale, whose opinion (Pleas of the Crown, 429) the American cases have followed. And it is to be noted that those cases have been decided in jurisdictions where the medical law was similar to the English. But it was early said that such a killing would be manslaughter in New York, where illegal medical practice is a misdemeanor. (*March* vs. *Davison*, 9 Paige, 584.)

* *McKleroy* vs. *Sewell*, 73 Ga. 657.

† *People* vs. *McGonegal*, 136 N. Y. 62.

‡ *R.* vs. *Stanton*, 1 Car. & Kir. 415; *R.* vs. *Case*, 19 L. J. M. C. 174.

§ *R.* vs. *Rosinski*, 1 Moo. C. C. 19. It was said in *R.* vs. *Case* that the evidence in Rosinski's case showed that the removal of the clothing was not an entirely voluntary act of the patient, but that defendant used some force; therefore the conviction of assault was maintainable. But the case is always cited to the effect stated in the text.

|| *Brinson* vs. *State*, 8 So. 527.

¶ *U. S.* vs. *Smith*, 45 Fed. 115.

cating liquor.* In Kentucky physicians, who are the only persons allowed to keep and prescribe liquor as a medicine within three miles of Newcastle Court-house, violate the law if they fail to record the sale in a book, and the statute so providing has been held to be constitutional.† In the same State Dr. Greene being indicted for "prescribing whiskey improperly," the court held this to be bad pleading; for prescription of whiskey is entirely consistent with propriety, and facts showing bad faith should be alleged.‡ In Oregon a physician selling any of the drugs enumerated in the act relating to poisons must show that he also prescribed it and kept the record required by law.§

Medical Societies have been incorporated very generally, for the purpose of increasing knowledge of medical science, fostering personal relations, and regulating professional conduct. New York, which in 1760 enacted her first statute forbidding unlicensed medical practice,‖ created in 1806 by a general act of incorporation a system of State and county medical societies,¶ "for the diffusion of true science, and particularly the knowledge of the healing art." Since that time kindred societies have grown up all over this country of a national, State, and county jurisdiction. In the beginning of the century quackery of every kind was rampant, as Carlyle has forcibly pointed out in his essay of Cagliostro; but the medical profession was comparatively homogeneous. There were individual pretenders, such as Thompson, whose disciples have been repeatedly indicted for manslaughter by ill-advised prescriptions of his specifics, "ram-cats" and "well-my-gristle,"** and who himself founded what was called the "botanic system," and Perkins, who established treatment by metallic tractors. But these men had no legal status as physicians belonging to incorporated societies. Reputable practitioners were not divided among themselves; and it was feasible to enact, as was done, that every practicing physician should upon notice join a county society under penalty of forfeiting his license in case of contumacy.†† This law is still in force in New York; but the incorporation of Homœopathic and Eclectic county societies has made it practically a dead letter; since in order to enforce it coöperation would be needed among the three societies. Therefore many legal practitioners do not belong, as the law contemplates they should do, to any county society. These organizations have, of course, all the powers specified in their charters and necessary to effect their purpose, preserve their being, and enforce their lawful discipline.‡‡ And it was early held that such a society could demand an initiation fee,§§ expel a member for gross ignorance or immorality, even though he had been tried and acquitted on the charges,‖‖ and also that it would not be directed by the writ of mandamus to admit to membership one whom it would have to expel

* *State* vs. *Benadone*, 79 Iowa, 90; 44 N. W. 218.
† *Sarris* vs. *Commonwealth*, 83 Kentucky, 327.
‡ *Commonwealth* vs. *Green*, 80 Kentucky, 178.
§ *State* vs. *Jones*, 18 Or. 256; 22 Pac. 840.
‖ Ch. 198, Laws of 1760; Livingston & Smith, p. 188.
¶ Ch. 138, Laws of 1806.
** *Lobelia inflata* of Linnæus.
†† Rev. St. of N. Y., Part I., ch. xiv., title vii., §§ 1 and 2.
‡‡ *People ex rel Bartlett* vs. *Med. Soc. of Erie*, 32 N. Y. 187.
§§ *People ex rel Dunnell* vs. *Med. Soc. of N. Y.*, 3 Wend. 426.
‖‖ *Ex parte* Smith, 10 Wend. 449.

immediately, e.g., a homœopath with an avowed intent to adhere to his belief in the doctrine of *similia*, *psora*, and the high potencies.* But where one who had in the past acted contrary to the medical code by advertising, being otherwise qualified and ready to abandon his misdoing, was refused admission to such a society, a mandamus was granted commanding his election, although it was conceded that if he should advertise after becoming a member, he would be liable to expulsion; the point being that advertising is not of itself immoral, and that the obligation of the code and by-laws does not exist until they are subscribed to;† but the same society was not permitted to expel a member who attended the county poor in violation of a rule establishing a tariff of charges, for the rule itself was considered contrary to public policy.‡ Dr. Fawcett was elected to the Alleghany County Medical Society in 1831, as a physician and surgeon, on producing his diploma from the Royal College of Surgeons of Edinburgh. "This document," says the report, "was in Latin, and it appeared that although the credential was handed about and inspected by the members of the society, the greater part of them could not translate it. It was, however, translated on the trial, and found to be only a diploma authorizing the practice of surgery." Dr. Charles, getting wind of this wicked deception, offered the following resolution: "Whereas, Henry Fawcett, by false pretensions, became a member of the Alleghany County Medical Society: therefore resolved, that we reconsider the vote taken at the last meeting in February, 1831, making Henry Fawcett a member of this society, and that he be no longer considered a member of the Alleghany County Society, until he qualifies himself to practice physic, etc., according to the laws of this State." This sounded so well that not only did the society adopt it, and as they supposed, expel Fawcett, but the *Angelica Republican*, with a kindly spirit of "newspaper enterprise," also published the proceedings. Whereupon Fawcett sued Charles for libel and recovered a verdict of one hundred and fifty dollars, which the Appellate Court sustained, saying that plaintiff's performance in palming off his Latin for more than it was worth was no ground for expulsion. "It was not breach of his oath, for he had taken none, nor of his official duty, for he was not yet a member," wherefore the court held that Fawcett, like Sandy's shilling in the box, "being once in was always in," and added, for the benefit of the society, and doubtless with unconscious humor, that "their proceedings were *coram non judice*."

Slander and Libel, therefore, are actions that will lie for wrongfully assailing a physician's professional reputation. It would be inadvisable to enumerate here the cases of this nature which have grown out of the careless speeches concerning medical practitioners, many of them being grotesque to a degree. Nevertheless, as a finger-post of warning to the impetuous and irascible, it may be worth while to cite a few instances, more or less modern, in which utterances concerning the practitioner of medicine have been held to be slanderous or libelous. Libel and slander are both malicious defamation of character. But the latter is by word of mouth; the former, by the more deliberate and enduring expressions

* *Ex parte* Paine, 1 Hill (N. Y.), 665.

† *People ex rel Bartlett* vs. *Med. Soc. of Erie*, 32 N.Y. 187; see opinion of Davis, P. J., at General Term, 25 How. 333; this case led to the enactment of Laws of 1866, ch. 445.

‡ *People ex rel Gray* vs. *Med. Soc. of Erie*, 24 Barb. 570.

that are apprehended by the eye—printed or written words, signs, pictures, or effigy.* But because *verba dicta pereunt, litera scripta manent*, and also because the deliberation of writing and perhaps revising the proof of a defamatory saying or joke shows greater depravity than does the sudden impulse of a speech, words that if spoken would be, in the mild eye of the law, innocent, become libels if printed or written. Slanderous words must defame a man with respect to his occupation in life or character; it is even said that they must impute crime or such ignominy as would exclude him from society; while to constitute libel it is sufficient if he be made ridiculous.

Thus words charging a physician with gross ignorance and unskillfulness or neglect in his profession may constitute either slander or libel, according as they are spoken or written.† To say of an unlicensed physician that he is a quack is not actionable, as we have already seen.‡ But it is otherwise if the person defamed have complied with the law although he adopt a "system" disapproved by the defamer. And if the imputation of quackery be made maliciously it will not be privileged, because it was made on the witness-stand. Doctors White and Carroll practiced medicine in Amsterdam, N. Y. White, though a graduate of a regular medical college, adopted and practiced homœopathy. Both attended Jay Phillips. Nevertheless Jay died, and his will being contested after the fashion of the time, both physicians were called before the surrogate to testify as to decedent's mental capacity. Dr. Carroll being asked if any other physician than he attended Mr. Phillips, answered, "Not as I know of." He was then asked, "Did not any physician attend him at the time he was at Mrs. Moore's, when you did not?" and he replied: "Not as I know of. I understand he had a quack; I would not call him a physician. I understood that Dr. White, as he is called, had been there." The jury thought that Dr. White was damaged to the extent of one hundred dollars by this aspersion.§ So to say of a physician, "He is no doctor; he bought his diploma for fifty dollars,"‖ is actionable. Where adultery is a crime, it is of course slanderous and libelous falsely to impute the guilt of it to any man or woman; but in the absence of statute making that offense criminal, it was held at common law that merely to impute it to a physician was not slander, because a man may be a good physician, or rather an able man in his profession, and yet play havoc with the seventh commandment;‖ but if the charge

* A learned text-writer (Townshend on *Libel and Slander*, ch. 1, p. 3, 4th ed.) is of opinion that "effigy" includes "gestures"; but the adjudicated cases do not seem to have determined the point. Gesture appeals to the eye, it is true, and not to the ear, but it is less premeditated and more transitory even than words. It would make a great difference in the case of the Sacristan cited by Ingoldsby, whether his subtle aspersion of character by gesture were slander or libel.

> "An uncle—so 'tis whisper'd now throughout the sacred fane,
> And a niece—whose father's far away upon the Spanish main.
> The Sacristan he says no word that indicates his doubt,
> But he puts his thumb unto his nose, and spreads his fingers out."

† *Carroll* vs. *White*, 33 Barb. 615; *Gauvreau* vs. *Superior Publishing Co.*, 62 Wis. 403; *Southee* vs. *Denny*, 1 Exch. 196; *Secor* vs. *Harris*, 18 Barb. 425.

‡ *Hargan* vs. *Purdy*, 20 S. W. 432 (Ken. Ct. Ap. 1892); *March* vs. *Davison*, 9 Paige, 580; *Skirving* vs. *Ross*, 31 Up. Can. C. P. 423.

§ *White* vs. *Carroll*, 42 N. Y. 161.

‖ *Bergold* vs. *Putcha*, 2 Th. C. (N. Y.) 532. To impute to a practicing physician general ignorance of medical science and lack of professional skill is actionable, with-

be of adultery with a patient, this involves professional character, and for such an imputation a physician of prominence recovered a verdict of twenty thousand dollars against the *Detroit Evening News*.* The *Rochester Democrat and Chronicle*, under the headline "A Narrow Escape From Being Buried Alive," narrated that farmer Hammell had been found frozen stiff in the highway, that coroner Purdy promptly sat on the body and was investigating the cause of death with his jury, when Dr. Lester insisted, despite the laughter aroused by his statement, that the farmer still lived, as indeed proved to be the case. It chanced that the coroner was also a physician, although the *Democrat* said nothing of the fact, and he brought his action in libel to recover damages. And let this case show how futile it would be to try to give to our definition a point like that of Ithuriel's lance, able to detect libel the moment the loathsome thing appears. The trial judge, being of opinion that the words were not libelous *per se*, directed a verdict for defendant. But verdicts by judges or juries are elusive. The General Term with one accord were of opinion that the words were libelous *per se*. For they said, with some appearance of argument, "Was it not calculated to bring disgrace or ridicule upon a physician to say of him in substance that he did not know on inspection that a man was alive or dead?" So they reversed the judgment below and ordered a new trial. But the Court of Appeals still remained, and thither the parties trudged in quest of justice. That court—also with one accord—reversed the General Term, for, said they: "It appears from the complaint and evidence that the plaintiff was by profession a physician and by office a coroner. In the article complained of he is referred to in the latter capacity only, and nowhere can be found a word or suggestion from which the most astute inquirer could infer that he had any other than that public occupation. As the language used did not relate to his profession in any way, so as to his office of coroner, it exhibits on his part a prompt and efficient performance of its duties; and it is impossible to see how any person reading it could ascribe to the words a defamatory meaning, or without the innuendoes apply them to the plaintiff in his professional capacity, and there is no evidence that such application was intended."† As the procedure allowed no further appeal, and the defendant had won the best two out of the three legal bouts, the coroner got no damages.

The audacity of those who do business by advertising presents another phase of this subject of libel. Dr. Clark applied to the courts for an injunction to prevent the use of his name by one Freeman, a manufacturer of "consumption pills," which were put in boxes and labeled with Dr. Clark's name. The injunction was refused on the ground that Freeman's act was libelous and therefore damages were recoverable at law; and when this is so equity refuses to interfere by injunction.‡

out proof of special damage. *Cruikshank* vs. *Gordon*, 48 Hun, 308; afd. 118 N. Y. 178. See *Lynde* vs. *Johnson*, 39 Hun, 12; *Carroll* vs. *White*, 33 Barb. 615; *Collins* vs. *Carnegie*, 1 A. & E. 695; *Long* vs. *Chubb*, 5 C. & P. 55.

* *Maclean* vs. *Scripps*, 52 Mich. 214.

† *Purdy* vs. *Rochester Printing Co.*, 26 Hun, 206; reversed, 96 N. Y. 372.

‡ *Clark* vs. *Freeman*, 11 Beav. 112. A droll action for libel was that of *Sullings* vs. *Shakespeare*, 46 Mich. 408; 41 Amer. 166. Plaintiff wrote a puff of himself which defendant, publisher of the *Kalamazoo Gazette*, misprinted, so that it read that Sullings had removed a "patty tuber" from the "hypogastrium" of A. B. Smith. Verdict for defendant.

But in a very recent case* the court at special term granted an injunction to Sir Morrell McKenzie restraining the use of his name by a manufacturing company to advertise certain salts of Carlsbad. The case never reached the Appellate Court. The use of his photograph as an advertisement is something that the public man may expect. He may approve of it or he may not. That makes little difference to the advertiser. An eminent English actor, whose face a great pill-maker has used as an advertisement, fled not long ago for rest and privacy to a little country town where he thought he would be unknown. He met two pretty children in his walks, who smiled in recognition as they passed. He turned and said: "My dear, do you know me?" "Oh yes," they said, "you're ——'s pills." And the player's dream of fame was realized. But when an abuse becomes intolerable, the courts find a remedy even if they shatter a tradition to do so. The use of a private person's likeness without his permission will be enjoined.† The relatives of a decedent have been able to procure an injunction ‡ to prevent the erection of a statue identifying their dead with a movement of a public nature, and there is reason to hope that the right of privacy and public decency will be more and not less enforced in the future.

DENTISTRY.

If Celsus said truly that all parts of medicine were so interwoven as not to be separable, argument is unnecessary to show that dentists belong to the class of medical men. It is common knowledge that the clergy were well-nigh the only practitioners of physic and surgery prior to A.D. 1163, when the Council of Tours, perceiving that the success achieved by the faithful was but a snare of the arch-enemy to divert pious souls from holy things to things temporal, issued the decree restricting excursions from the cloister and the absorbing practice of healing arts by priest or monk. Thereafter surgery fell into the hands of smiths and barbers; in oblivious commemoration whereof the barber erects his pole to this day. The greater surgical operations soon fell naturally into the better educated and more skillful hands, and surgeons formed into colleges; but "tooth-pulling," which by some is even yet understood to constitute dentistry, remained until comparatively recently, together with cupping and leeching, part of the barber's business. And if it be true that the world takes us at our own estimate of ourselves, it is in no small degree the fault of dentists themselves that they continued so long to occupy a less dignified plane of usefulness than their medical brethren, the physicians and surgeons. Their advertisements by hideous displays of artificial teeth and instruments, their lack of organization, ethical rules, and *esprit du corps*, possibly even the similarity of the dental chair to that of the barber, all tended to preserve the old tradition, especially when joined with a steady flow of conversation not far removed in subject and quality from that of the gentlemen of the pole. "*Attaqué, calommnié, ridiculisé comme le chirurgien ou le médecin au temps de Molière, le dentiste a eu pendant une bonne partie de le siècle un sort peu enviable.*"

* *McKenzie* vs. *Soden Mineral Springs Co.*, 27 Ab. N. C. 402, 18 N. Y. Supl. 240.
† *Pollard* vs. *Photographic Co.*, 40 Ch. D. 345; *Marks* vs. *Taffa*, 26 N. Y. Supl. 908.
‡ *Schuyler* vs. *Curtis*, 27 Ab. N. C. 387; 24 N. Y. S. 509.

Code du Chirurgien-Dentiste, par MM. Roger et Godon, Paris, 1893.) But all this has been changed. The organization of societies and colleges, the enactment of registration and license laws, the extraordinary progress of dental art and science, and the high character of their leading exponents, have been such as to elicit admiration, and some enthusiasts have gone so far as to consider dentistry a separate profession, which it is undesirable to "hitch on to the tail of the medical kite to give it ballast for a higher flight"*—a proposition not to be rashly accepted.

However this may be, the practice of dentistry, and the relations of the dentist to his patient so far as the law is concerned, are governed by the same rules already laid down in the preceding pages. The question has indeed been raised in the courts as to whether a dentist was a tradesman, an artisan, or a professional man. Thus a dentist who made at her request two sets of teeth for a lady, who died before she could try them in, was held in a suit against her executor incapable of recovering their value upon the ground that the action was not for services but for goods sold and as such not maintainable under Section 17 of the Statute of Frauds.† In a Mississippi case, decided in 1856, the question at issue being whether dental instruments were exempt from levy under execution as mechanical tools, the court held that they were not, because dentistry is not a trade.‡ In a similar case, however, in 1868, Chief-Justice Cooley held that such instruments were exempt from levy under attachments. The learned jurist did not hold a dentist to be "a mechanic," as Mr. Rogers suggests;§ nor do his words quoted by that excellent writer fairly bear such an interpretation. His decision went no further than to hold that the vocation is of a duplex nature; that dental operations are for the most part mechanical, "and so far as tools are employed they are purely so;" but is not this so of the surgeon's saw? The court said: "Indeed dentistry was formerly purely mechanical, and instruction in it scarcely went beyond manual dexterity in the use of tools; and a knowledge of the human system generally, and of the diseases which might affect the teeth and render an operation important, was by no means considered necessary. Of late, however, as the physiology of the human system has become better understood, and the relations of the various parts and their mutual dependence become more clearly recognized, dentistry has made great progress as a science, and its practitioners claim, with much justice, to be classed among the learned professions."‖ The most recent expression of judicial opinion that dentistry is a medical specialty is in Flickinger's case,¶ wherein the Missouri statute exempting "a medical practitioner" from jury service was held to apply to one lawfully practising dentistry. The court said: "While dentistry as an independent calling may have had a humble and comparatively recent origin, it has now become a very important branch of medical science.

* *Dentistry a Specialty of Medicine*, by N. W. Kingsley, D.B.S., *Medical Record*, November 27, 1886. *Is Dentistry a Specialty of Medicine?* by the writer, *Medical Record*, December 4, 1886.

† [illegible] vs. [illegible], 38 L. J. Q. B. 252; cf. *Gilman* vs. *Andrus*, 28 Vt. 241, where a husband was held liable to pay for his wife's teeth.

‡ [illegible] vs. [illegible], 31 Miss. 567.

§ Rogers, *The Law and Medical Men*, p. 170.

‖ [illegible] vs. [illegible], 17 Mich. 332.

¶ *State ex rel. Flickinger* vs. *Fisher*, 21 S. W. 446, 593.

[Address of N. S. Davis, M.D., president of the American Medical Association.] The fact that this branch of the medical profession has grown to such proportions as to have its own independent colleges and to confer its own degrees, and that it has become necessary that its practice should be regulated by statute, indicate the importance of the exercise of its functions to the public welfare. The fact that it is regulated in a separate article, and as an independent calling from that of an M.D., does not in any manner affect the character of those functions."

The Dental Act of 1878* regulates the practice of dentistry in the United Kingdom, and places it, like medical practice, under the supervision of the General Council of Medical Education and Registration, whose functions in dental as in medical matters are discretionary and not controllable by mandamus.†

In France the practice is regulated by the recent law of November 30, 1892. Germany, Austria, Switzerland, Belgium, Spain, Italy, Norway, Sweden, Finland, Denmark, and Russia, all prescribe rules of license.‡

In this country Alabama seems to have been the first State to enact a dental law. At present such laws are in force in Arkansas, Connecticut, District of Columbia, Georgia, Indiana, Kentucky, Maine, Massachusetts, Michigan, Minnesota, Missouri, Mississippi, New Hampshire, New York, North Dakota, Ohio, Oregon, Rhode Island, South Carolina, Vermont, Virginia, Wisconsin. The Dental Act of 41 & 42 Vict. is very similar to the Medical Act in its provisions, and up to the present year the diplomas of Harvard and Ann Arbor have been recognized as entitling their holders to registration thereunder. But it was decided by the General Council lately (in 1893) to discriminate no longer as between American diplomas, none of which now entitle their holders to register as dentists. The French law has so recently become operative that its results cannot be criticised. The statute confines practice of dentistry to doctors of medicine or surgeon dentists, the diploma of the latter class to be conferred by the government, after a course of study to be promulgated by the higher council of public instruction and examinations. Illegal practice is punishable by a fine of from fifty to one hundred francs for the first, and from one hundred to five hundred francs for the second offense.

To make a synopsis of the statutes of our States is hardly worth while in this place, for the same reasons that have caused an omission of a like synopsis of the medical laws. In this transition and formative period the statutes are subject to change by every legislature; and the only safe practical guide for one desiring to begin the practice of dentistry in any State is to consult its most recent statute book. A summary of the law made to-day might prove to-morrow a mere Jack-o'-lantern misleading the inquirer. It may be said generally, however, that the prevalent requirement of license is that the candidate shall appear before a board of dental examiners appointed by the State or State Dental Society, and either satisfy them that he holds a diploma from a college in good standing, or submit to their examination. And we have already seen that the courts will not allow a State Board to delegate its powers to a national association.§

* 41 & 42 Vict. c. 33.

† *Partridge* vs. *Gen'l Council Med. Ed. & Reg.; L. R.*, 25 Q. B. 90.

‡ *Code du Chirurgien-Dentiste, supra.*

§ *Illinois State Board Dental Exrs.* vs. *People*, 123 Ill. 227.

The contract of the dentist is governed by the same rule as to the standard of skill and knowledge which applies to the physician. A dentist must have and exercise the reasonable and ordinary knowledge, skill, and care of his profession.* In a New York case it was said that a dentist owed the highest degree of skill and care to a patient under the influence of an anæsthetic, and that the fact that the operator instead of extracting the tooth of the unconscious man let it slip down his throat, was sufficient proof of negligence to carry the case to the jury.† In administering chloroform, however, it was said in a Pennsylvania case that a dentist was only bound to look to the natural and probable effects of the anæsthetic.‡

It has been seen above that the confidential relations between physician and patient render extraordinary agreements by the latter in the former's favor suspicious; and in a grotesque case where a dentist took from a pensioner of Greenwich Hospital a bill of exchange for £262 10s. upon an alleged agreement to keep the old gentleman supplied with teeth for the rest of his life, the court held the agreement to be a gross fraud.§

Partnerships, signs, and such matters are, of course, regulated by the ordinary rules of law in such cases provided. And so far as signs and advertising are concerned, there is no call to cite authorities in a book intended for professional men.

PHARMACISTS.

Reference has been already made to the manner in which the apothecary became in England a general practitioner of medicine, being succeeded in his ancient and narrower function by the pharmacist and chemist. In the practical administration of medical laws, constant complaint is heard against "counter-prescribers," so called, who are the true successors of apothecary Rose, who made the great fight against the College of Physicians and Surgeons. It is chiefly in sparsely settled districts and the poorer quarters of great cities that the druggist assumes to act as a physician. The test of whether he violates the law in any instance must be determined by the particular facts of each case, for, as was said by Mr. Justice Hawkins in a case already cited, "It is idle to lay down a golden rule upon the subject."‖ It becomes always a question of fact whether under the proven circumstances the druggist merely sold an article, as he is entitled to do, or prescribed it after the manner of a physician.

A druggist is responsible for all injury due to his lack of reasonable knowledge, skill, and care. He is bound to know the properties of medicines and to employ competent assistants, for whose acts in the course of his business he is also liable. In the leading case of *Thomas* vs. *Winchester*¶ the defendant was held liable for injuries resulting from a mis-

* *Simonds* vs. *Henry*, 39 Me. 155.
† *Keily* vs. *Colton*, 1 City Court (N. Y.), 439.
‡ *Bogle* vs. *Winslow*, 5 Phila. 136.
§ *Allen* vs. *Davis*, 4 De. G. & S. 133.
‖ *Apothecaries Co.* vs. *Jones* (1893), 5 R. 101; 1 Q. B. 89; 67 L. T. 677.
¶ 6 N. Y. 397.

take of his assistant in labeling a jar of belladonna as dandelion, which jar was first sold to one Aspinwall, by him to Ford, and by Ford to the plaintiff. In two Kentucky cases* druggists were held liable, the one for selling cantharides on a prescription calling for snake-root and peruvian bark, the other for selling croton oil instead of linseed; and in Michigan† a defendant was held liable for his clerk's error in dispensing sulphate of zinc for Epsom salts. But although a druggist sells a poisonous drug without labeling it, he is not responsible for its reckless use by one whom he has warned of its properties,‡ and he is entitled to have the competency of his clerk submitted to a jury, together with the question whether there was actual negligence in the case.§

Although one who manages a pharmacy is required to have a certificate of competency under the statutes of many of the States, nevertheless one who is not entitled to such certificate may invest his money in a pharmacy and employ a duly certified agent to carry it on;‖ but he cannot take part in the conduct of the pharmacy himself.¶

A pharmacist entitled to register, and who has applied so to do and paid his fee, has been held not liable under the statute of Illinois if the Board of Pharmacy failed to register him.**

The sale of poisons and intoxicants being now almost universally regulated by law, it behooves both physicians and druggists to know the statutory regulations of their domiciles in this regard. The fact that intoxicants or poisons are sold under a physician's prescription is no defense if the vendor has no license.††

Under the British Pharmacy Act,‡‡ forbidding the sale by unregistered persons of certain poisons, but exempting patent medicines, the exemption is held not to embrace all proprietary remedies, but only those covered by letters patent.§§ But a sale of poison under the act is not established by proving the sale of a compound containing an infinitesimally small quantity of a poison defined by the act.‖‖

An unregistered assistant, who in his master's absence sells a poison, is liable to the penalty under this statute.¶¶

There is a joyous opinion in a Georgia case of interest to physicians, druggists, and laymen alike, for it holds that whiskey is not a drug. The term drug, said the learned and experienced court, "carries along with it an idea inseparable from it, of something repulsive, nauseous—at which the gorge heaves. Whiskey, on the contrary, is inviting, exhilarating." And the court also argued with profundity that a drug is so hard to sell that merchandise difficult to dispose of is commonly

* *Fleet et al* vs. *Hollenkemp*, 13 B. Mon. 219; *Hansford's Admx.* vs. *Payne & Co.*, 11 Bush. 380.

† *Brown* vs. *Marshall*, 47 Mich. 576.

‡ *Wohlfahrt* vs. *Beckert*, 92 N. Y. 490.

§ *Beckwith* vs. *Oatman*, 43 Hun, 265; afd. 132 N. Y. 94.

‖ *Commonwealth* vs. *Johnson*, 144 Pa. St. 377; 22 Atl. 703.

¶ *State* vs. *Norton*, 67 Iowa, 641.

** *Carberry* vs. *People*, 39 Ill. Ap. 506.

†† Druggists cases, 85 Tenn. 449. Liquor cases, 37 Am. R. 284. Compare with English cases below, as to what is a sale of liquor or poison.

‡‡ 31 & 32 Vict. c. 121.

§§ *Pharmaceutical Socy*, vs. *Piper* (1893) 5 R. 296; 1 Q. B. 686; 68 L. T. 490.

‖‖ *Pharmaceutical Socy*, vs. *Delve*, L. R. 1894, 1 Q. B. 71.

¶¶ *Pharmaceutical Socy*, vs. *Wheeldon*, 24 Q. B. Div. 683.

so called; whence it would seem to follow that to call whiskey, the sale of which is proverbially easy, a drug,* would be a "palpable misnomer." But where the question is one of selling on Sunday, it would seem that over the border such toothsome delicacies as peppermint lozenges will be held *prima facie* to be a drug or medicine.†

* *Gault* vs. *State*, 34 Ga. 533.
† *Reg.* vs. *Howarth*, 33 U. C. Q. B. 537.

INDECENT ASSAULT UPON CHILDREN.

BY

W. TRAVIS GIBB, B.S., M.D.

Definition.—According to the English and American Criminal Codes, indecent assault is ordinarily defined as the mere touching, by a man, of the genital organs, breasts, or legs of any female not his wife, without her consent, even though the parts are covered with clothes. In the French and most of the German codes the offense is designated as "unchaste conduct." Should the female be under the age of legal consent, the act, even with her consent, would constitute the crime of indecent assault upon a child.

Legal Aspect.—There is little or nothing in the medico-legal literature pertaining directly to the crime of indecent assault upon children, except as embraced under the heading of ordinary indecent assault upon a female. Reese, in his *Medical Jurisprudence*, states that as this crime is usually committed in secret and without witnesses, the law receives the evidence of a single person, the complainant or prosecutrix, as sufficient to establish the charge. In the State of New York a law has been recently passed which permits the testimony of a child, even though she is too young to understand the nature of an oath, to be submitted to the jury for what such an appearance is worth without the formality of administering the oath. As false accusations are exceedingly common, medical evidence becomes of the greatest importance as corroborative proof, and it is therefore exceedingly important that the physician examining the child should be particularly careful in making his examination and framing his report, for it is frequently upon his testimony that the prosecution depends, especially if there have been no witnesses to the assault, and the victim is too young to give competent testimony.

According to most penal codes, the consent of a child, even though she is under the legal age for consent to sexual intercourse, to the commission of an act of indecent assault is considered a sufficient defense to the charge; but in the State of New York the accused man may be prosecuted, even though the child has given her consent, under Section 289 of the Penal Code, which states that:

"A person who

"1. Willfully causes or permits the life or limb of any child actually

or apparently under the age of sixteen years to be endangered, or its health to be injured, or its morals to become depraved;

"2. Willfully causes or permits a child to be placed in such a situation or engage in such an occupation that its life or limb is endangered, or its health is likely to be impaired, is guilty of a misdemeanor."

While the term "indecent assault upon a child" usually implies the indecent act of an adult male toward a female under the age of consent, it is equally applicable to the indecent assault of an adult female upon a male child, or of an adult female upon a female child, or of an adult male upon a male child. These latter varieties of indecent assault are not as common as the first, but it is undeniably true that they occur much more frequently than is generally supposed, although but few of the cases are brought to public notice, owing to the difficulty of proving the charge, which, from the peculiar nature of the offense and the lack of physical evidence upon the victim, would require strong corroborative testimony in order to secure a conviction. This corroboration would necessarily be lacking, for if the accused is in full possession of his or her senses, a third party would not likely be permitted to witness the assault. Authentic instances of indecent assault of adult females upon male children are comparatively rare in the literature upon the subject, because their actions toward the child, even though they might arouse the suspicions of a witness, could be easily and satisfactorily explained. Krafft-Ebing (*Psychopathia Sexualis*, p. 377) mentions the case of a married woman, thirty years of age, who enticed a boy of five, by means of money and sweetmeats, committed an indecent assault upon him by lustfully handling his genitals, causing him to handle hers, and then endeavored to cause him to have intercourse with her.

Women suffering from nymphomania or some other variety of sexual perversion, or merely for the purpose of revenge, have been known to make an indecent assault upon the sexual organs of a male or female child and produce such an amount of damage that the cases have been brought to the notice of the criminal authorities. There are a number of recorded cases where an adult female, with the design to so enlarge the genital organs of a child as to fit her for sexual intercourse with men, introduces her fingers, candles, round pieces of wood or stone into the child's vagina. In the observance of the Phallic worship of ancient Egypt, stones shaped like the adult male genital organ were forced into the vaginæ of children in order to prepare them for sexual intercourse. The practice of thus injuring children is common in southern countries, and mothers themselves will frequently inflict these injuries upon their own children for the purpose of selling them into prostitution, very young children being particularly desirable for sexual intercourse, especially by old men. Casper mentions the case of a girl ten years of age, whose vagina had been dilated in this way by her mother, who first used her fingers as dilators and then forced a long smooth stone into the vagina. Ogston refers to this iniquitous practice in Edinburgh, and describes the peculiar funnel-like dilatation, which is likened to the mechanical enlargement mentioned by Tardieu and other writers, and found in passive pæderasts.

In Taylor's *Medical Jurisprudence* is mentioned the case of a man who committed a rape upon a child, who admitted that he had first used a stick to enlarge the vaginal orifice. Several years ago, in New York

city, two boys attempted to commit a rape upon a girl nine years of age, and finding her vagina too small, forced sticks into it in order to enlarge it.

Penalty.—In this country, in most of the States in which the crime of indecent assault is recognized as a separate offense it is considered a misdemeanor. In New York, according to the new penal code, it is classed as an assault in the third degree. In some States, notably Louisiana and Mississippi, no such offense is recognized under the specific term of "indecent assault," such an assault being considered an assault with the intent to commit rape. In the States where the crime is classed as a misdemeanor, the average penalty is one year in the penitentiary. Sometimes a fine, or both a fine and imprisonment, are imposed. In New York the penalty is one year in prison or a fine of five hundred dollars, or both. In the States where the crime is considered a felony, the penalty is greater and the confinement is in state-prison, notably: California, two and a half years in state-prison; Illinois, one to fourteen years; Michigan, not more than ten years, or a fine not exceeding one thousand dollars, or both. No difference is made in the penalty whether the victim of the assault is an adult or a child. (See Rape, etc., vol. ii.)

Age of Consent.—While the age of consent of females has no bearing upon the penalty for the crime of indecent assault, and according to the common law the consent of a child of tender years is considered a sufficient defense for the crime, it is of great importance in determining the age under which a child must be in order that the person accused of the crime of indecent assault may be prosecuted for endangering the morals of the victim. In the majority of States a child is considered capable of giving consent at the age of fourteen years. In Alabama and Mississippi the age of consent is ten years; in Louisiana and Texas it is twelve; in Iowa it is thirteen; in Nebraska it is fifteen; in New York and Pennsylvania it is sixteen; and in Kansas and Wyoming it is eighteen.

Undoubtedly the largest proportion of cases of indecent assault upon children occur among the older girls, but in most of these cases the child's consent has been obtained, and the assaults are but seldom reported to the criminal authorities, as but little or no physical injury is done these girls by an indecent assault alone, and there has been no witness. When the children are very young, the perpetrators of the assault are either insane or intoxicated, and the physical injury is much greater than in the first class of cases, and they are consequently more likely to be brought to public notice.

Varieties of Indecent Assault.—A common form of indecent assault upon children is where an adult male or female permits or compels a child of either sex to perform an act of manustupration upon him or her. Numerous instances of this variety of assault have been brought to my notice as examining physician of the New York Society for the Prevention of Cruelty to Children, but as there is usually no corroborative testimony and no physical evidences upon the child, the cases seldom find their way into court. No injury except a moral one has been done the child, and unless the crime has been witnessed by some third person, the evidence of the victim, who is often too young to testify, is not sufficient to secure a conviction. If the child is old enough to give com-

petent testimony, he or she will often try to shield the accused, especially if the act was done with the subject's full consent.

"The annals of legal medicine distinguish as the equivalents of the impossible physiological sexual act, exhibition of the genital organs, lustful handling of the genital organs of children, inducing them to perform manustupration of the seducer and performing masturbation and flagellation of the victim. In this stage the intellect may be sufficiently intact to allow avoidance of publicity and discovery, while the moral sense is too far gone to consider the moral significance of the act and resistance of the impulse." (*Psychopathia Sexualis*, p. 40.)

Another variety of indecent assault which has frequently been brought to my notice in the examination of children is where a man, for the gratification of a perverted sexual appetite, applies his mouth and tongue to the external genital organs of a female child. This act, designated by the term "cunnilingus," while it is, strictly speaking, an indecent assault, is classed under the "crimes against nature," and is punished by a longer term of imprisonment. A remarkable instance of this species of moral depravity was the case of Mamie Prosser, a well-developed child of eleven years, whom I examined for the Children's Society in September, 1892. She was a typical example of a New York street urchin, dirty and uncared for. Three men and two boys attempted, with her consent and for the payment of five cents, to have sexual intercourse with her, but failed, as her vagina was too small. The child stated that two of the men, finding they were unable to effect sexual intercourse, applied their mouths to her vulva. The men admitted that they had done so. All five pleaded guilty to the charge of abduction and were sentenced to state-prison.

Another case in point was that of the manager of a "female base-ball team," a man fifty years of age, who was convicted after a long trial of the crime of abduction. The child, the so-called "mascot" of his base-ball team, an extremely pretty, well-developed girl fifteen years of age, was examined in July, 1892. She admitted that numerous acts of sexual intercourse had occurred between her and the accused, with her full consent, however. On the witness-stand she stated that the accused man, before he was able to have sexual intercourse with her, had compelled her to perform masturbation upon him upon numerous occasions, and that he had frequently performed the act upon her. He was tried upon the charges of rape and abduction, and convicted upon the latter. The charge of indecent assault was not pressed, as there was no evidence to corroborate that of the child.

The Accused.—In my experience, criminal assaults upon children are usually perpetrated by men who are insane, old men beyond the age of virility, men under the influence of liquor, and those suffering from some form of perversion of the sexual instinct which may be akin to insanity. In southern countries, where children are frequently employed for sexual intercourse by men, the indecent assaults upon their genitals are made for the purpose of first enlarging these organs. Other varieties of indecent assaults, including cunnilingus and manustupration, are usually perpetrated by sexual perverts. Those developing senile dementia due to brain atrophy and psychical degeneration first exhibit a sexual perversion by lascivious speech and gestures in the presence of females; then they devote their attention to children, because of the

better facilities for secret gratification, but more especially because of their knowledge of their own deficiency in sexual power which would keep them from approaching adults. This perversion of the sexual impulses in very old men may be explained by reason of their defective sexual powers and greatly diminished moral sense. Other motives impelling an adult to make an indecent assault upon a child may be jealousy or a desire on the part of the perpetrator to obtain revenge upon the parents or friends of the child for some real or supposed injury.

The usual defense advanced by the accused perpetrator of an indecent assault is an alibi, which, if sustained, is necessarily a complete defense. He may also attempt to prove that the offense was committed with the child's full consent by showing that the assault occurred in a place where the child had but to make an outcry to have obtained assistance. The accused frequently claims that the child solicited the assault, but even had she done so, he can be held and prosecuted (in the State of New York) under Section 289 of the penal code. Another line of defense offered by the defendant is that he placed his hands under the girl's clothes at her request in order to arrange some article of her dress that had become loosened, and that it was not his intention to violate chastity. The absence of any corroborative testimony or marks of violence upon the child, especially if the accused can prove a uniformly good character, would undoubtedly cause him to be given the benefit of a reasonable doubt if tried.

False Accusations.—False accusations of indecent assault upon children have been brought against men, sometimes intentionally and at times unintentionally. Intentional false accusations are usually brought for the purpose of revenge, and in such cases the child will have been taught the story she repeats. Cases are recorded where the parties interested in procuring the accusation have so irritated the genitals of the child as to make them appear as if an assault had actually taken place. Such cases rarely go so far as a trial in a criminal court, as their real merits are easily discovered if the child is made to tell her story while apart from her friends or those particularly interested in making the accusation.

What was apparently an instance of an unintentional false accusation of indecent assault was brought to my notice in a case where a man was accused of placing his hands under the clothes and upon the person of a child three years of age. The complainant was an old woman who lived in a house adjoining that of the accused, her windows being on a level with his, but situated on the opposite side of a fifteen-foot courtyard. She testified that she had seen the accused place his hands under the child's clothing on several occasions as he and the child were standing at the window of his apartment. The offense appeared so plain to her that she made complaint, and the man was arrested. I examined the child, but could find no evidences of injury. On the trial the accused man stated that he had merely buttoned the child's drawers, which had become loosened. There was no corroboration of the complainant's testimony, and the child was too young to testify. The man produced witnesses to vouch for his good character, and he was acquitted.

Severity of the Assaults.—Indecent assault upon children varies in the severity of its effects from the merest physical contact of the hands of the assailant upon the genital organs or breasts of the child, leaving

no evidences upon the child which can be det
iner, to injuries so severe and extensive, invo
but any other portion of the body, as to pro
absence of any marks of external violence up
no physical injury has been done or because
have disappeared in the lapse of time betw
amination, the testimony of the medical exa
portance except upon questions as to the po
such injuries and their results.

The child usually states that "he put his
sometimes that "he took off my drawers and p
or again, "he put something into me that
(Taylor's *Medical Jurisprudence.*) It is the
brought to the attention of the medical exa
jury found will depend entirely upon the vio
strument used in its commission, and the
committed. The victim's body will present e
portion to the violence used and the resistan
The body and limbs may present ecchymo
assailant's grasp, contusions, scratches, and
but the genital regions are usually the more
injury. These injuries may consist of an
genitals from friction, contusions, burns, s
from the introduction of the finger or other
meat-skewers, sticks, and stones, into the vag
rupture of the recto-vaginal or vagino-perito
than those upon the genitals cannot be calle
decent assault, but form additional proof wh
genital regions or corroborating testimony t

The mere presence of evidences of chara
child's genitals should not be taken as conc
assault, for such injuries may frequently be
with the finger or any other object which m
any accidental injury may account for the co
the presence of filth or disease may be resp
excoriated condition of the child's genital r
amination. In all cases of doubt the med
exactly the condition he finds present, leavi
the condition to the general testimony in the

A vaginal or vulval discharge frequently
and is usually due to the injury of the mucou
structures, or to the communication of some
hands. This indirect communication of a
easily accomplished should a man, suffering
venereal disease, first handle his own genital
make an indecent assault upon the genitals
from the victim's privates may be mucous, m
according to the character and severity of t
doubtful cases cultures and microscopical e
for the determination of the gonococcus wh
of the discharge plain. Investigation of th
should also be made.

Evidences of a recent violent indecent assault consist in severe inflammation and tumefaction of the vulva, abrasions of the mucous membrane and skin about the genital regions, bleeding, more or less tearing of the deeper structures, hymen completely or partially lacerated, vaginal mucous membrane torn and ecchymotic. Severer injuries, such as complete rupture of the recto-vaginal or vagino-peritoneal septa, are recorded, but fortunately are not commonly met with.

In one case which I examined for the Society for the Prevention of Cruelty to Children in August, 1893, the child, eight months of age, had been raped by her father, a robust Italian about thirty years old. The child had been very severely injured, and when I examined her I found a complete rupture of the perinæum, extending into the anus and involving a portion of the recto-vaginal septum. I also examined the father, and found a large abrasion upon the dorsum of his glans penis. His actions plainly indicated that he was insane. The child's injuries were of such a nature that I do not believe they could have been produced by the forcible introduction of the father's penis alone without causing greater injury to that organ. It is my opinion that the man, suddenly seized with an insane desire for sexual intercourse, attempted to rape his own baby, but finding her parts too small, tore out with his finger the perinæum and recto-vaginal septum, and then was able to insert his penis. The man was subsequently examined and pronounced insane.

Another case of this kind brought to me for examination from the same society was a girl, seven years of age, who stated that several hours previously a Chinaman had removed her drawers and then inserted his finger into her vulva. On examination I found blood oozing from her genitals, the parts were congested and irritated, and on separating the labia I detected a tear through the base of the hymen upon the right side, separating it from the lateral vaginal wall for a distance of three eighths of an inch, extending entirely through the hymen like a buttonhole, but leaving its free margin intact. The tear was undoubtedly produced by the finger-nail.

A very aggravated case of what was undoubtedly indecent assault was that upon a child five years of age by her father. She claimed that the prisoner had on several occasions introduced a pencil and a wooden meat-skewer into her vagina. On examination I found her genitals inflamed and irritated, and the hymen completely and recently ruptured, the edges being ragged and bleeding. At the trial the child was considered too young to give competent testimony, and as there were no other witnesses to the assault, the accused was given the benefit of a reasonable doubt and discharged.

Examination.—In making an examination of a child upon whom it is suspected that an assault has been perpetrated, it is always advisable to strip it entirely, so that a thorough examination of the entire surface of the body can be made in order to detect any contusions or abrasions which might form additional evidences of violence. I recently examined two children, sisters, aged nine and seven years respectively, whom an Italian tied to a tree and outraged. He succeeded in committing rape upon the older child, and in the violence of his attack she was very seriously injured. Upon the younger child he only succeeded in committing an indecent assault, and upon stripping her I found numerous

contusions upon the arms and body, but the most characteristic injuries were upon her thighs, where I found contusions corresponding to the exact imprints of his thumbs upon the inner aspect, and of his four fingers upon the outer aspect of each thigh, showing how he had grasped the child in order to force her thighs apart. There were no injuries upon the genitals. The accused man was tried and convicted upon the charge of rape committed upon the elder girl, the child upon whom he had committed the indecent assault being used as a witness against him.

In examining the genitals care should be taken to note every abnormal condition, for in these cases the injury produced by the assailant may be so exceedingly small that the scratch of a finger-nail, the rupture of the hymen from the introduction of some foreign body, or the contused imprint of a finger may be all the examining physician is able to detect. The exact time and date of the alleged assault and of the examination should be noted carefully in order that the physician may determine whether the condition of the injuries would indicate that they had existed for a longer or a shorter period than that which has elapsed since the assault.

The examination of the child's injuries should be made as soon as possible after the alleged assault, for the evidences of physical injuries, unless they have been extremely serious, will disappear within a very few days. The condition of the genitals as to cleanliness and disease should be carefully noted, for it is frequently found that the irritation and discharge from which she is suffering, and which are thought by her friends to be the result of an indecent assault, are merely the natural consequences of filth and neglect, or sometimes to ascarides that find their way from the rectum to the vulva and vagina.

The largest majority of the cases of indecent assault upon children occur among the poorest and most depraved classes of people, and if the child has escaped serious physical injury no notice may be taken of the occurrence. In fact, unless the child is very young or the assault has been witnessed by a third person, the knowledge of it may not reach the child's parents at all. If, however, the child has received a serious injury, she is usually taken to a dispensary or some free medical institution for treatment, where for lack of time too often little attention is paid to the cause of the condition from which the child is suffering, the physicians' entire efforts being directed to the appropriate treatment. Even if a history of an indecent assault is given, the physician is sometimes loath, especially if the injury is slight, to report it to the proper authorities, fearing, if he does so, that he may be brought to court as a witness. In many of these cases a careful examination by the attending physician into the character and cause of the vaginal irritation and discharge from which a child is suffering might reveal cases of rape and indecent assault which otherwise would remain unknown, and when such cases are known it is the duty of any physician to report them to the proper authorities. Many of the vaginal discharges for which children of this class are brought for treatment are gonorrhœal in their origin, and due to an indecent assault or attempted rape, but which are considered by their physicians, for lack of proper inquiry, to be cases of simple vulvitis or vaginitis due to filth or some constitutional disease.

As far as practicable the medical examination of the child should be made without giving her or her friends warning, for in cases of false accusation the friends, or the child herself, desiring to have the charge substantiated by the corroborating testimony of the examining physician, might easily so irritate the genitals as to make it appear as if the assault had really taken place. Any refusal on the part of the friends to allow an examination of the child's genitals by a properly authorized disinterested physician would form a strong point in circumstantial evidence against the accusation.

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NAME	DATE DUE
A. H. Ehrenclou	NOV 30 1914 ret. Dec. 1, 1914
E N Smith	ret. Dec. 15, 1914
Dickson	ret. Dec. 16, 1915 DEC 6 1915
[illegible]	ret. July 1916
U. S. Veterans Bu.	SEP 1 1933